DECEMBER 1956

Power Engineering

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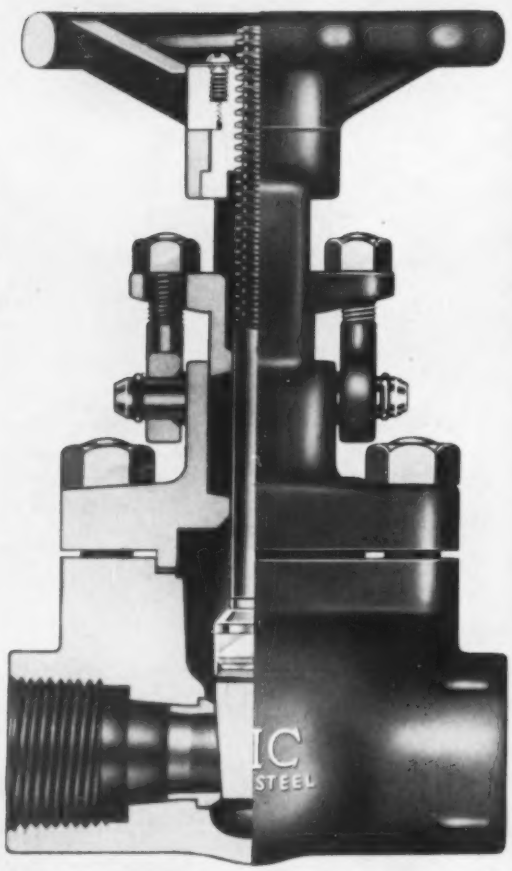
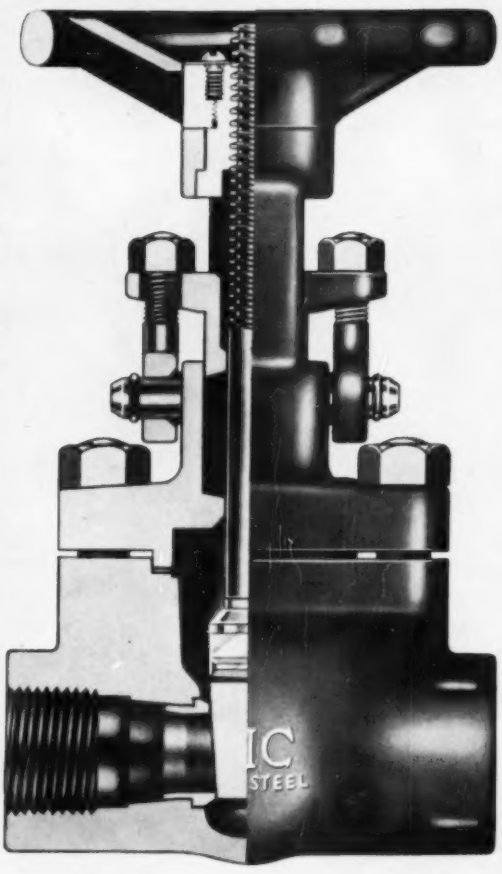
1100 LINE



1300 LINE



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2 new rugged OIC forged steel lines

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Most valve users have applications suited to both of these new OIC valve lines. Write for Bulletin *#195-R* illustrating features and specifications that fit these newest forged steel valves to your services.

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Improved

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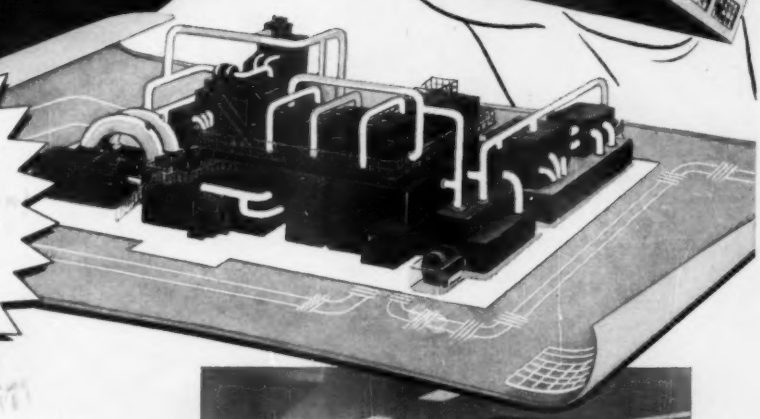
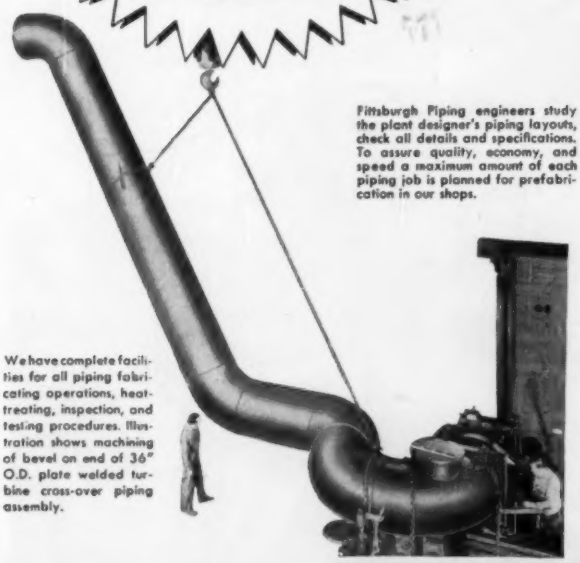


Pittsburgh Piping engineers study the plant designer's piping layouts, check all details and specifications. To assure quality, economy, and speed a maximum amount of each piping job is planned for prefabrication in our shops.



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PP-21

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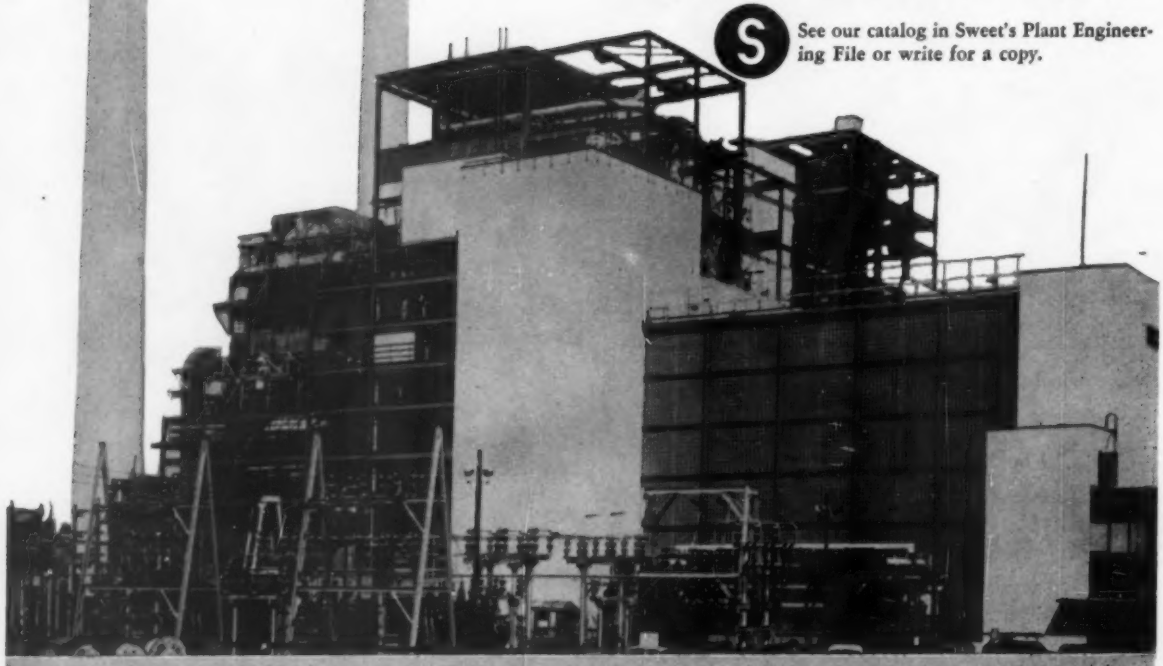
S See our catalog in Sweet's Plant Engineering File or write for a copy.



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110 S. DEARBORN ST., CHICAGO 3, ILL.
DEARBORN 2-5446

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Change of Address: Send to POWER ENGINEERING, Circulation Division, Barrington, Illinois. Please supply your position title, company name, company address. Request must reach us by 15th of month to make the change effective with the following month's issue.

Subscription Information: Published monthly; price in U. S. and possessions $10 per year; in Canada $11 per year; other countries $12 per year; single copies $1.

Indexed in the Industrial Arts Index and the Engineering Index on file in public and many private libraries.

Microfilm edition: Request prices from University Microfilms, Inc. Ann Arbor, Mich. All volumes since 1948.

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ENGINEERS' PREVIEW

FOR SOME YEARS now, we have been occasionally mentioning to young women interested in secretarial work that engineers, and particularly professional engineers, need good secretaries who know something about technical work. At least they should know enough, or be able to learn enough very quickly, to be of great help as engineering secretaries.

Accordingly, we are much pleased to learn that an organization called The Business Training College has set up a special engineering secretarial course designed to produce exactly this type of secretaries, both young men and young women. This college has planned a course that not only trains them in secretarial duties but attempts to give them enough scientific background, in addition, so they will have some understanding of this type of work. The background subjects include chemistry, physics, advanced mathematics and the terminology of the various fields of engineering. In addition, an intensive course in filing and blueprint reading along with the use of the varityper, is provided. Of course, such secretaries must have some natural aptitude for these fields. But if they have, and can acquire some of this background, engineers will snap them up.

UTILITIES COMMISSION, Orlando, Fla., has ordered 2 gas turbine-generator sets with a combined capacity of 33,000 kw from General Electric Co's Gas Turbine Department in Schenectady, N. Y., it was announced by C. H. Stanton, Utilities Commission Manager. This application is the largest known usage of gas turbines for peak power generation in the United States.

The gas turbines, which are each rated at 16,500 kw, are of the simple-cycle, single-shaft design with an inlet temperature rating of 80 F. The units are designed for dual fuel operation — burning either distillate oil or natural gas.

The 1st unit is scheduled to be shipped in July, 1957, and the 2nd one in October, 1957. They will both be installed in the Commission's Municipal Power Station. Operating together, the gas turbine-generator sets could supply enough electricity to adequately satisfy the average yearly needs of over 55,000 persons.

FIRST steel mill gas turbine installation using a waste heat boiler has been ordered from the Westinghouse Electric Corp by the Altos Hornos de Mexico steel mill at Monclava, Mexico.

Exhaust gas at 750 F will be used in a waste heat boiler to generate steam that will drive a steam turbine. The steam turbine will drive an air compressor supplying air for blast furnace blowing.

The 8100-kw gas turbine will operate at 4700 rpm and will consume 3,655,000 cu ft of natural gas daily. Gas will be supplied from a 200-mile pipeline. A gas turbine was chosen for expanded needs due to a limited water supply; the gas turbine needs one-third the amount of water required to operate a steam turbine of equal capacity.

PROGRAM TO TRAIN able young men to become engineering technicians has been started by Lake Forest College and the Fansteel Metallurgical Corp.

Objectives are to help prospective technicians fill gaps in their educational background, enabling them to perform many time-consuming duties now assigned to highly trained engineering school graduates.

Now taking courses at Lake Forest College, in English, chemistry, physics and mathematics, are a dozen Fansteel employees. Fansteel pays for their tuition and books and gives them time off for classes. Some of the courses are given at the college, others in the Fansteel plant at North Chicago.

"The plan recognizes the fact that many youngsters have good minds, but have not had the opportunity to go to college," said John Meade, vice president and director of industrial relations at Fansteel.

"We want to see these individuals get where they should be. They need some mechanism to get them back on the educational track."

ALLIS-CHALMERS has announced that pilot scale tests at the company's new Carrollville Development Laboratory have shown that fly ash can be substituted for shale or clay as the raw material from which modern portland cement is made. This offers several important advantages to both utilities and cement producers which can be cooperatively explored.

For example, Wisconsin Electric Power Co has announced that it plans to supply approximately 50,000 tons per year of fly ash to the first unit of Marquette Cement Company's new Milwaukee plant. About 15 to 16 per cent of Marquette's raw material feed will be made up of fly ash used as a substitute for shale.

In outlining other developments in the utilization of fly ash, Allis-Chalmers announced that carbon removal from the ash can be accomplished with commercially available gyratory screens.

With this equipment, screening at 200 mesh, about 50 per cent of the combustibles were removed.

Some good data on utilization of fly ash were given in POWER ENGINEERING's articles, Who'll Buy My Fly Ash, April 1954, and Fly Ash Hits the Road, October 1954. Refer back to them if you have a fly ash disposal problem.

TYPE OF TRAINING necessary for the engineering profession and the engineer's role in planning the world of tomorrow are subjects of a new non-technical, color movie just released by the College of Engineering of Ohio State University.

This new 20-minute sound film, "Engineering For Eddie," centers on the fairy-tale world of little Eddie Smith. It is designed to serve as a guide to today's youngsters, and their parents, in evaluating the educational requirements and practical applications of engineering training.

The movie is to be shown to general audiences and outlines the contributions of the engineer to the state and the nation. The production defines the engineer's role — both social and scientific — and attempts to answer four questions:

"Forget the ladder. Pete has his own method of working"

What is an engineer? Why is he needed? What does he need to know? How does he become an engineer?

The film is available on a free-loan basis or for purchase from the Department of Photography, Motion Picture Division, Ohio State University, Columbus 10, Ohio.

COLOMBIA'S fast growing industrialization has created the need for a vast expansion of the nation's electric power facilities and the government is meeting it with plans for a huge hydroelectric project.

Colombia's National Public Service Corp has completed plans for construction of a 470,000-kw capacity station on the Bata River, about 65 miles northeast of Bogota, as the major phase of its program to create power production of 3,000,000 kw by 1965.

In the meantime, however, the government has launched work on several smaller electric projects in order to keep pace with present requirements. Some of these are being financed by local communities with some government aid; others are being wholly financed from the national treasury and some assistance will be asked from the World Bank

Government engineers plan to build a 2-mile-long tunnel from a fall in the Bata River to a generating plant that will be included in the project. This, they say, will produce 200,000 kw of electricity. Later they plan to build a dam across the gorge above or below the falls to create a reservoir, and permit an enlarged generating plant to produce 470,000 kw.

Although Bogota, Medellin, Barranquilla and other major cities of Colombia will be amply provided with electric power under the new program, it is in and around industrial Cali that the Public Service Corp is concentrating its attention. There big American firms depend entirely on energy generated by their own Diesel electric plants. Firms have doubled or tripled their plants within the last five or six years, with a resulting need for more electric power. Because of this increasing demand, the government also has under construction in Cali a steam generating plant capable of producing 100,000 kw and expected to be completed by 1959.

The U. S. engineering firm of Gibbs & Hill are consultants on the national electrification plan, which is expected to cost about $600,000,000 to complete.

POWER ENGINEERING Microfilm—1955

POWER ENGINEERING, Vol. 59, covering all 12 issues and index during the year 1955, is now available in Microfilm, No. 166. Price—$4.55.

Write POWER ENGINEERING
110 S. Dearborn St.
Chicago 3, Ill.

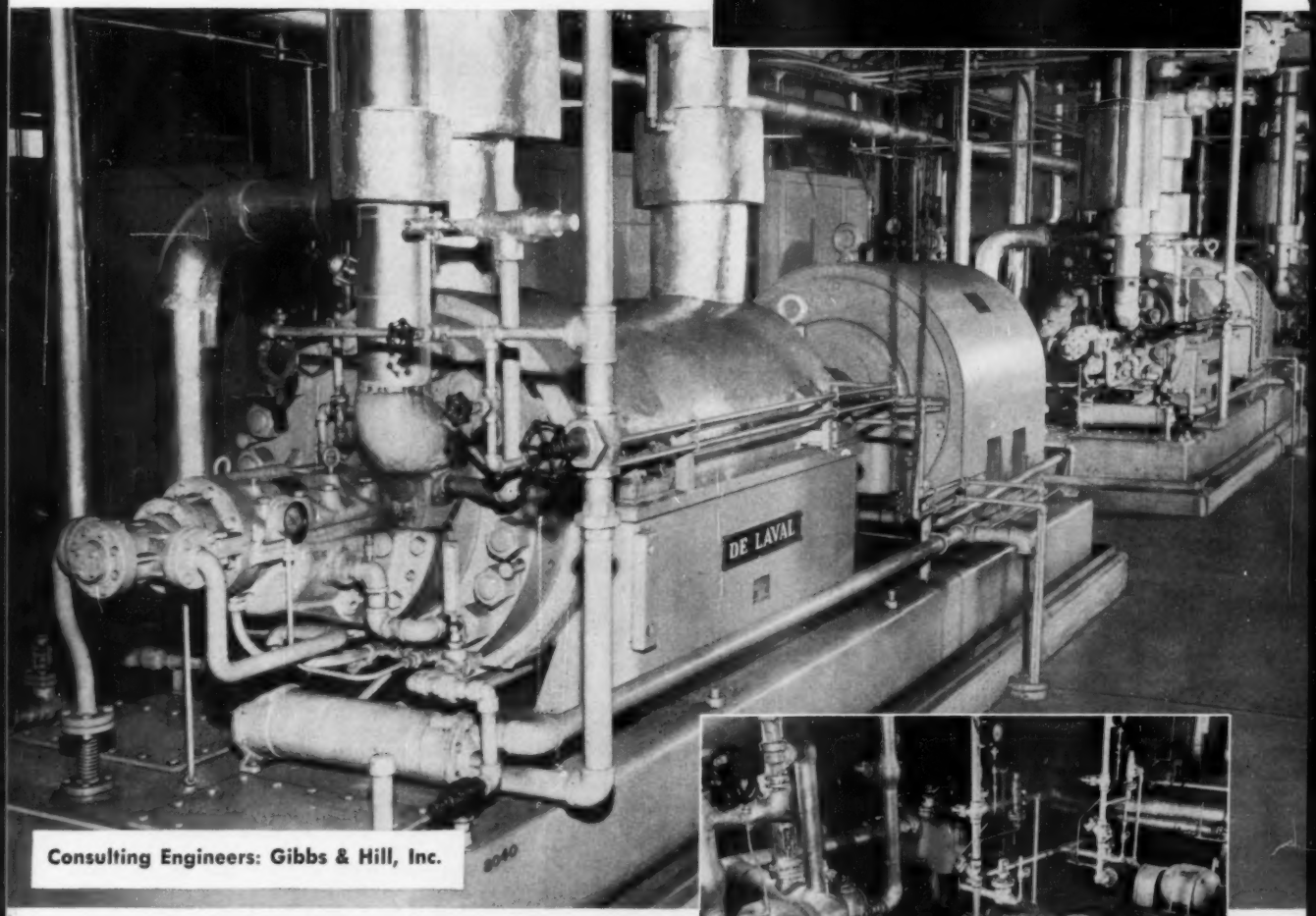
INTERNATIONAL PAPER Co., Pine Bluff, Ark., has ordered 2 steam turbine-generator units with a total capacity of 60,000 kw from the General Electric Co for installation in the paper firm's new $57,000,000 newsprint and bleached kraft board mill.

One unit is rated at 40,000. The steam turbine is of the condensing, single automatic extraction design and will use steam initially at 1250 psig at 950 F. The turbine will drive a 3600 rpm, 51,200 kva generator. The other unit is rated at 20,000 kw. This steam turbine is of the non-condensing, single automatic extraction type designed to use steam at an initial pressure of 1250 psig at 950 F.

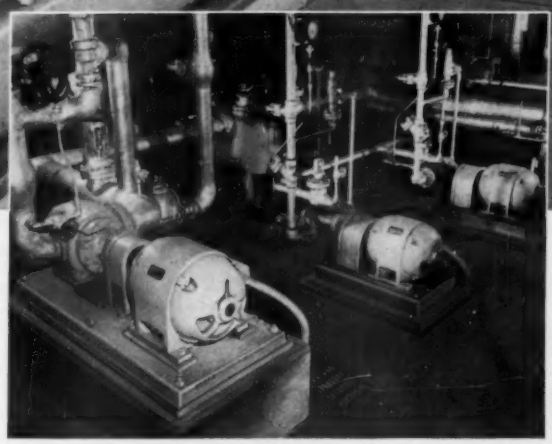
The new Pine Bluff mill of International Paper Co. is expected to have an annual production capacity of 130,000 tons of newsprint and 165,000 tons of bleached kraft board.

Atlantic City Electric ... another utility using

DE LAVAL
BARREL TYPE BOILER FEED PUMPS



Consulting Engineers: Gibbs & Hill, Inc.



De Laval IMO rotary positive displacement pumps handle heavy fuel oil. They are used for standby operation.

Atlantic City Electric Co. and Gibbs & Hill, Inc., Consulting Engineers, know that they can count on De Laval reliability. That's why they selected three De Laval high pressure barrel type boiler feed pumps for the Deepwater Station in Penns Grove, New Jersey. These 10-stage units deliver 675 gpm, operating at 1762 psi with temperature at 287 F. The pumps are driven by 900 hp motors.

De Laval barrel type boiler feed pumps operate at pressures up to 5500 psi. These units offer many important design advantages, such as double volute diaphragm, individual diaphragm bolting, only one inner high-pressure joint, and bare shaft construction. Their dependability is proven by year in, year out service in public utilities and industrial plants.

Send for De Laval Bulletin 1506, which contains helpful data.

DE LAVAL *Boiler Feed Pumps*

DE LAVAL STEAM TURBINE COMPANY
816 Nottingham Way, Trenton 2, New Jersey

DL-343

WHAT THEY TELL US

▶ **READERS** of POWER ENGINEERING are not expected to be professional painters themselves. But nobody in the whole engineering profession should have more information or opinions, or both, about the results of the painting that the professional painters do for them. For that reason, we say . . . Readers — Help!

Reader E. A. M., who is in the business of painting power plants and power plant equipment (and any other industrial equipment) has a problem. He says:

> Having read the various articles by L. G. Jones on Power Plant Painting in POWER ENGINEERING, I thought you might be in a position to advise me on this problem. (*Editor's Note:* — Mr. Jones, formerly on the staff of one of our largest outstanding power utilities, is now in Europe and unavailable for comment.)
>
> We have a contract to paint two large unlined steel stacks that attain a temperature of 350 F. The specifications state that these stacks must be finished in a buff color to match adjacent structures and that the work must be guaranteed for 3 years.
>
> Essence of the problem, we believe, lies in the color. Our concern would be greatly minimized if we could use the aluminum or blacks. In trying to meet the above specifications, we believe we are courting paint failure to a high degree. Can POWER ENGINEERING readers give us any comments on this from their own experience?

Come on, power engineers, — especially any of you who have ever tried to paint stacks or power equipment a buff color. Can it be done satisfactorily or not?

▶ **SOMEBODY** does us oldtimers dirt! exclaims Reader E. F. Hathaway of Massachusetts. He continues:

> In the October issue, page 91, is a picture entitled Old Corliss Engine, located in Massachusetts. Having operated quite a few Corliss engines 'way back when they were numerous, this does not look like a true Corliss to me, but like what was known as a Rollins. There were a few of these around here, and I operated one for a time, about 25 years ago.
>
> The Rollins had gridiron steam valves and Corliss exhaust valves, with the operating cranks on the back of the cylinder for the exhaust, the same as in the picture.
>
> Real Corliss engines were very popular in these parts before the turbine took over. Some ran to quite large sizes. The Harris Corliss and the Rice & Sargent were made right here, in Providence, R. I.
>
> We have an old Harris cross compound, about 500 hp, which still makes juice in an emergency. When put in, it was too big, now it's too small.
>
> I think some of the other has-beens will agree with me. It is really nostalgic to ride around now . . . mills gone or closed, and engines gone to the scrap pile.

Our face is red, and you probably are right. That looks like a Rollins engine and not a true Corliss.

We'd like to add that some of us share your nostalgia. But the interesting thing is that this change has occurred during the single lifetime of many engineers not yet much over 60.

▶ **SATURATED STEAM NEEDED?** G. N. of California writes:

> We are operating a laundry and dry-cleaning plant from a 100-hp hrt boiler; we carry 110 psi steam pressure. Steam lines both to laundry and dry-cleaning plant are tapped off from the steam header.
>
> On the dry-cleaning header we have a reducing valve set for 80 psi. The dry-cleaning operator claims the steam is too dry for efficient work on his presses and spotting table.
>
> I have two ideas for giving him saturated steam. One is a form of condenser like a long coil radiator to be installed somewhere in the dry-cleaning header line, where space permits, with a bypass in case it does not prove practicable.
>
> The other idea is to insert a cold water line inside the steam header line and return the water to the hot water tank.
>
> Kindly let me know what you think of these ideas, and if you have a different one.

Here's what we told G. N.:

To begin with, do you really require 110-psi steam in the laundry? Reason we ask is this: You are adding about 10 F superheat to your steam by reducing its pressure from 110 psi (header pressure), to 80 psi (press pressure). If your laundry or other facilities can get along on 80 psi, then you could keep the header (boiler output) at 80 psi saturated and bypass the pressure-reducing valve. You could save the 10 F superheat by this method alone.

If this is not possible, you might install a desuperheater valve downstream from the reducing valve. This device will spray cold water into the 80 psi steam and reduce its temperature very close to saturation temperature.

Your idea of a condenser coil in the 80 psi line would work, but you would not have much control of the cooling and you would waste the heat removed. You would end up by requiring a regulating valve to mix the straight steam and the cooled steam in a proportion required to maintain the best degree of saturation for the presses.

If you are going to do this, you may as well put that coil in a tank and preheat your water supply going to the laundry water heaters. Such tempering tanks are often used; but they make the press room dependent on the laundry requirements. If the laundry is shut down, it needs no hot water and the steam flow through the tempering tank coil would have to be stopped or you would boil the cooling water. If not this, then you would have to discharge the cooling water to the sewer, and we understand California is getting a little fussy about wasting water.

As for your idea of putting a water pipe inside the 80 psi steam pipe, here again you would have no control over the cooling of steam. When the laundry used a lot of water, your press room steam would probably be too wet to use. When the laundry was using no water, it would be too dry to use (as now). So it would call for regulators to keep (1) the steam at the right temperature, and (2) the water at a safe temperature.

Probably the best thing to do is the first thing suggested (reduce boiler pressure to 80 psi) and the second-best would be to install a desuperheater valve.

Comments from readers, and other ideas for helping G. N., will be most welcome. Send them to What They Tell Us, POWER ENGINEERING, 110 *S. Dearborn St., Chicago 3, Ill.*

▶ **MOST PLEASANT** to editorial eyes are these comments from Marvin E. Rule, plant engineer, Department of Buildings and Grounds at Princeton University:

> Praise, and praise only for your magazine! Always full of interesting articles.
>
> One query! Why don't you continue the Plant Problems or Q&A, or some such set of aggressive articles for a man to get a bit heated over because he thinks differently from you. . . . Competition of thought, like competition of selling, makes for healthier men and business. But don't stop POWER ENGINEERING Handbook.
>
> Please send me the parts and instructions for the Transmission Line Calculator . . . another *First!*

Move 15 tons at a pass . . .

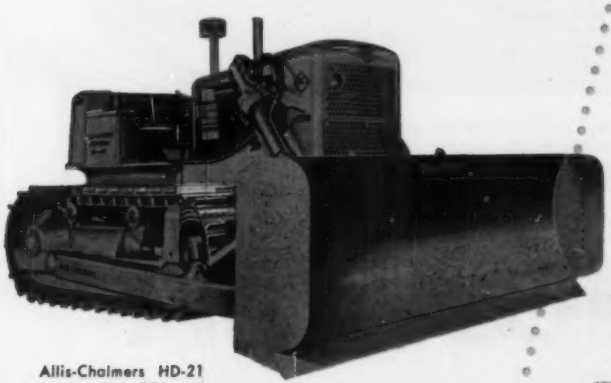
using Allis-Chalmers HD-21 Tractor with special coal blade

A special coal-handling blade now available for the Allis-Chalmers HD-21 fully uses the tremendous power and weight of this big tractor to move 15 tons of coal at a time.

HD-21 is coal-handling specialist— With its 204-hp diesel engine, the HD-21 has plenty of power for moving big loads. The hydraulic torque converter drive multiplies drawbar pull up to four and a half times, automatically accelerates to the highest traveling speed conditions permit. The torque converter permits climbing steeper grades, prevents killing the engine or digging in at soft spots, eliminates effort and time lost in shifting.

The compacting effect of a crawler tractor is well known. Through repeated trips over the coal pile, the 26-ton HD-21 and blade eliminate voids, prevent spontaneous combustion. The blade is shaped to move coal easily with a minimum of coal separation.

Dependability of the HD-21 is assured by Allis-Chalmers advanced design — Box-A Type Main Frame, one-piece steering clutch and final drive housing, straddle-mounted final drive gears, roller bearing truck wheels, through-hardened track rails — which also mean long life, less maintenance and faster repair when necessary.



Allis-Chalmers HD-21 tractor has 204 net engine hp, weighs 26 tons complete with cable or hydraulically controlled blade. Special coal blade has extra 56½-in. height and 15-ft length, plus boxed-in ends to carry 15 tons or more at a pass.

For additional information about the HD-21 tractor and coal blade — or about the other Allis-Chalmers tractors, tractor shovels, scrapers and motor scrapers — see your Allis-Chalmers construction machinery dealer or write direct to the company.

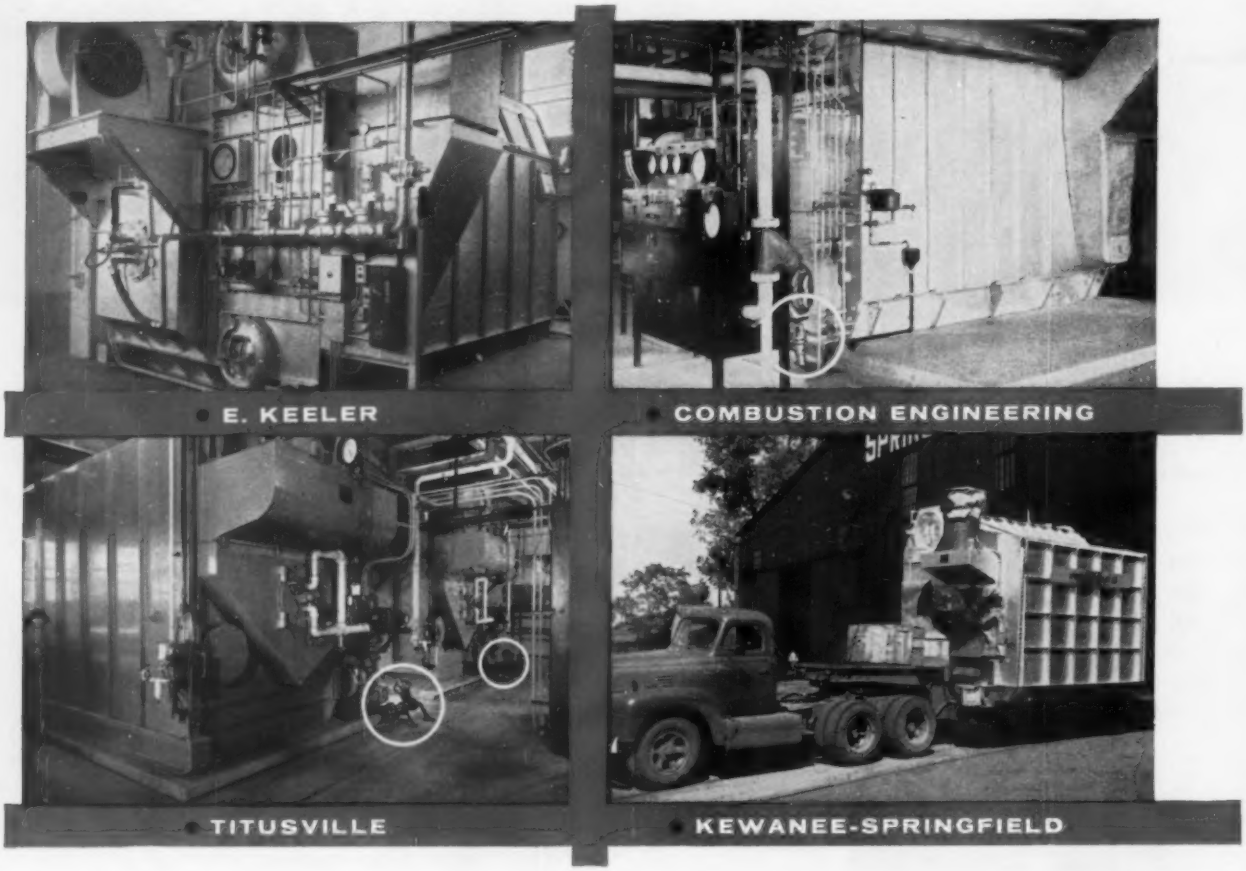
ALLIS-CHALMERS, CONSTRUCTION MACHINERY DIVISION
MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

For more data circle 505 on Post Card

the blow-off valve trend on "package" boilers is

YARWAY SEATLESS



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YARWAY® BLOW-OFF

■ More and more leading manufacturers of package-type boilers are featuring Yarway Blow-Off Valves on their units. Many are standardizing on Yarways.

The reason—good blow-off valves help good package boilers *perform better*.

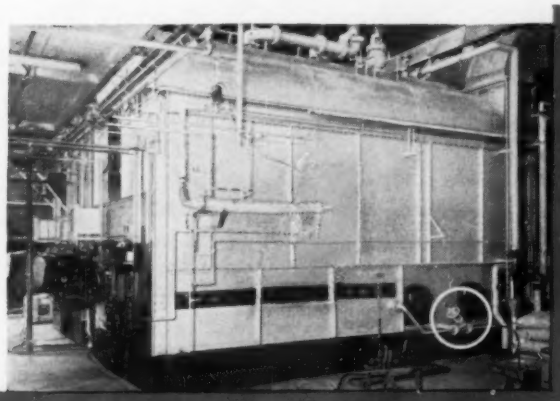
Yarway—known for nearly 50 years for *quality* blow-off valves—offers advanced design, dependable service, and reasonable cost . . . three features attractive to all boiler users.

The Yarway Seatless Blow-Off Valve, with balanced hollow sliding plunger and no seat to score, wear, clog or leak, is the most widely used valve for low and medium pressures.

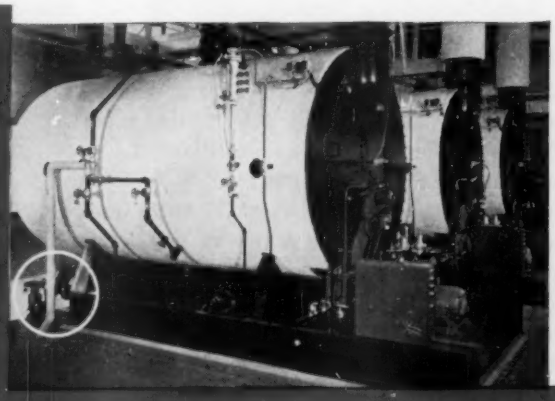
Specify Yarway Seatless Blow-Off Valves on your package boilers. All boiler makers will supply them.

For full description of Yarway Seatless Blow-Off Valves write for Yarway Bulletin B-426.

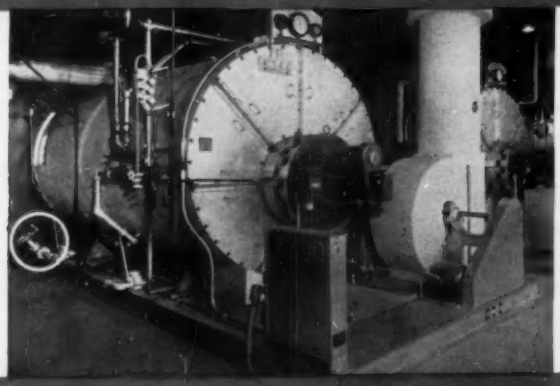
YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES



● ERIE CITY



● CLEAVER-BROOKS



● PREFERRED UTILITIES

● **Yarway Seatless Tandem Blow-Off Valve** (angle-straightway combination) with angle valve sectioned to show balanced sliding plunger design.

● **Yarway Seatless Tandem Blow-Off Valve,** angle-angle combination, straightway-angle or straightway-straightway tandems also available.

VALVES

For more data circle 506 on Post Card

Separately Fired Superheaters Cut Cost of Atomic

Con Edison's 236,000 kw Nuclear Power Plant will depend upon FW superheaters for 96,000 kw of its capacity and save about 27% in total plant cost per kw

FOSTER WHEELER will supply the superheaters for the Indian Point Plant of Consolidated Edison Company of N.Y., to be located on the Hudson River, 24 miles north of New York City. The design of these units reflects Foster Wheeler's more than 60 years of experience in building superheaters for major power plants from coast to coast—including more than 18,000 units and over 90% of all the radiant superheaters in use today.

This Indian Point project represents an important forward step toward the economical generation of electricity from nuclear power. For it is the nation's first atomic power plant to utilize separately-fired superheated steam and demonstrate the cost-saving effects of this method of generation.

Saturated steam from the new pressurized water reactor will be superheated from 447F to 1000F by two Foster Wheeler separately-fired superheaters, each with a capacity of 1,075,000 lb per hr at an operating pressure of 410 psia. Initially oil-fired, the superheater design will be such that convenient conversion to coal firing may be accomplished, if desired, at some future date.

The decision to use separately-fired superheaters for the Indian Point plant was made after detailed economic studies, comparing plant capacity and initial cost, as well as estimated annual power costs, for plants operating on saturated and superheated steam. These studies included superheating the steam from 447F to 860F, 1000F and 1050F, but the 1000F superheat was found to be the most economical. Compared to operation with saturated steam direct from the reactor to the turbine, addition of the superheat cycle raised plant capacity from 140,000 kw to 236,000 kw, and resulted in a reduction in estimated plant cost from $322 per kw to $233 per kw. These comparative cost and capacity figures are tabulated below. The use of superheated steam will also reduce turbine maintenance, further contributing to lower cost of atomic power generation.

Foster Wheeler's long experience in steam generation and specialized nuclear know-how, offers a valuable service to the power industry, for the planning and construction of both nuclear and fossil fuel fired steam plants of the future. For further information, write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

ESTIMATED COST AND CAPACITIES

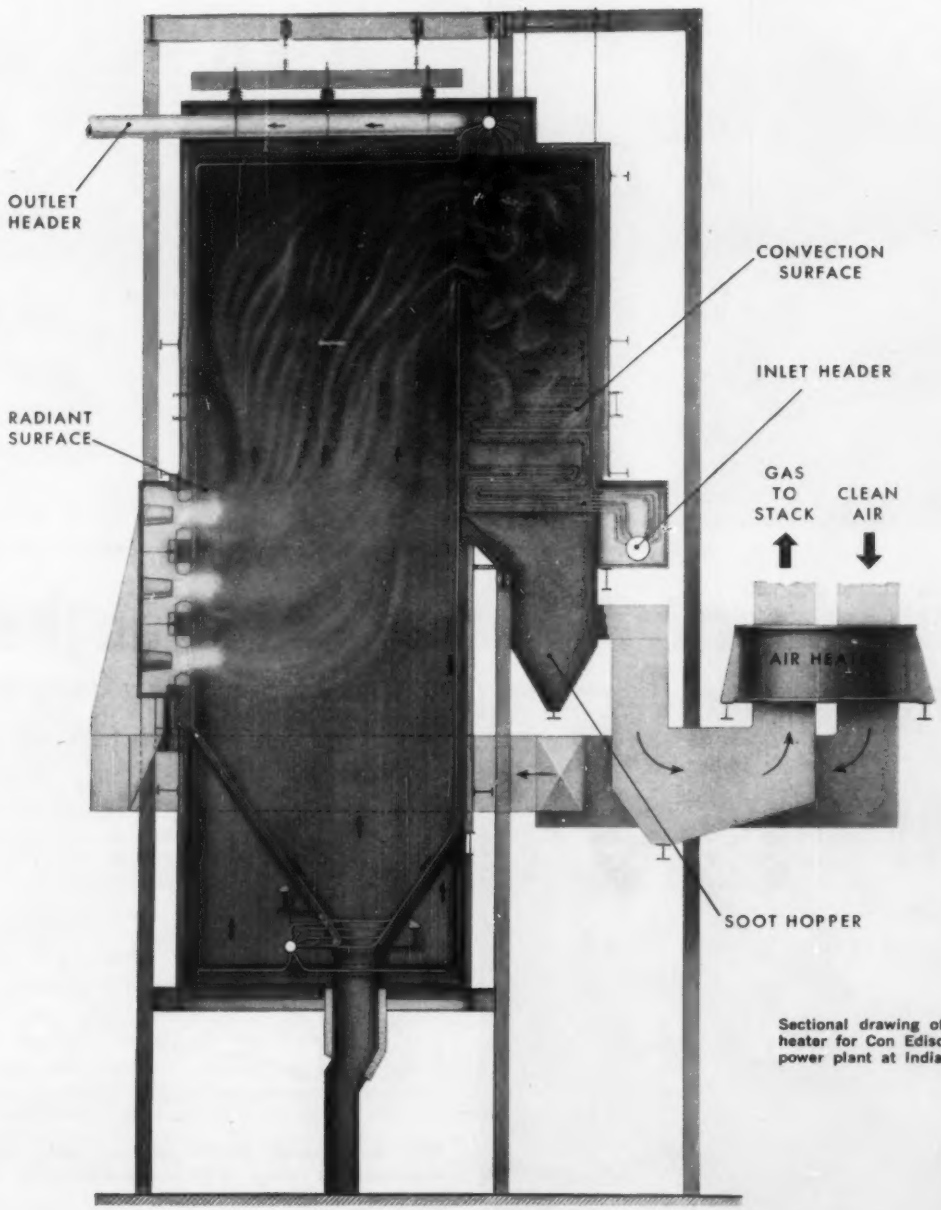
	Total Plant Cost	
	Saturated Steam	Superheated Steam
Steam Pressure at Boiler, psia.....	420	420
Steam Pressure, Turbine Inlet, psia.	405	370
Steam Temperature, Turbine Inlet..	446F	1,000F
Turbine Plant Heat Rate, Btu/kwhr..	12,900	10,700
Gross Electrical Output, kw	140,000	236,000
Total Cost of Plant, million $.....	45	55
Total Plant Cost Per kw, $.....	322	233

FOSTER

NEW YORK • LONDON

by FW

Power at Indian Point



Sectional drawing of separately-fired superheater for Con Edison's 236,000 kw nuclear power plant at Indian Point, N.Y.

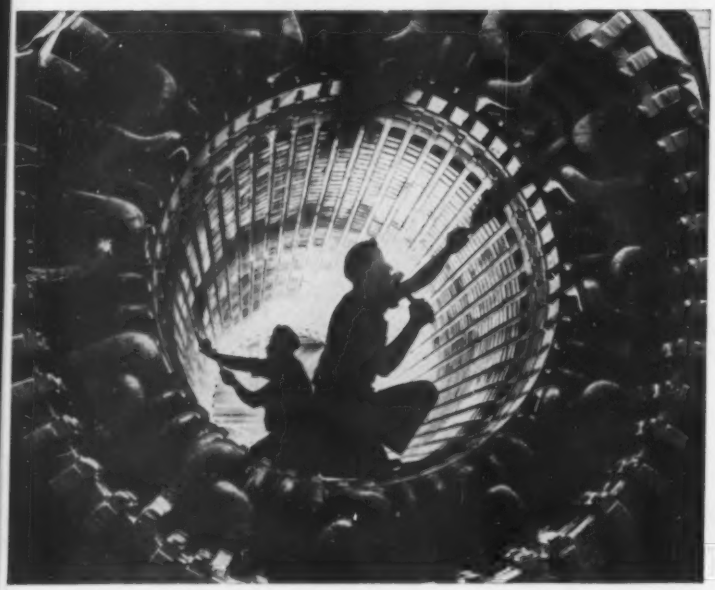
WHEELER

PARIS • ST. CATHARINES, ONT.

For more data circle 507 on Post Card

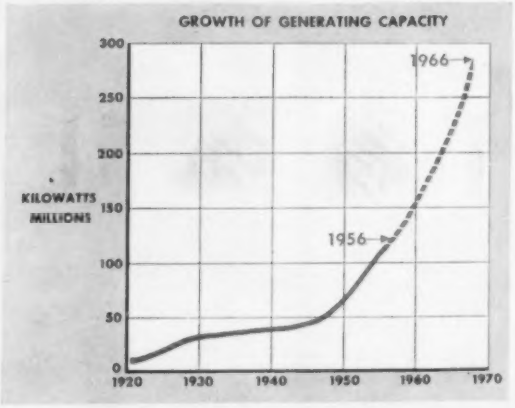
CAREFUL PLANNING FOR PRODUCTIVE MAINTENANCE INCLUDING STOCKING SPARE PARTS

How *Productive* Maintenance can help



THE FACILITIES of the world's finest turbine plant and 46 service shops located throughout the country back your General Electric unit.

TO MEET TOMORROW'S EXPANDING LOADS



G.E. works with electric utilities and consulting engineers in these vital turbine-generator areas:

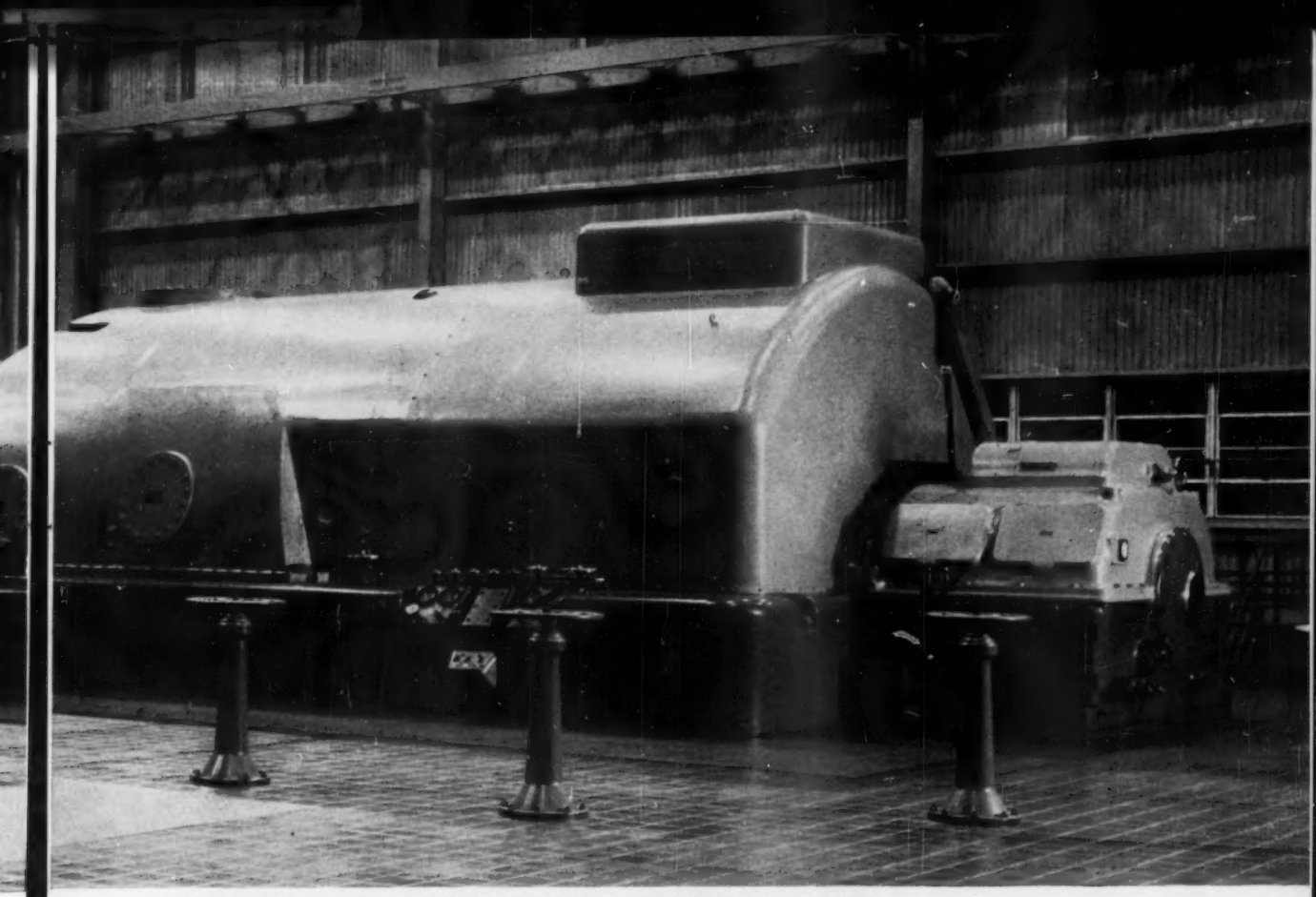
BASIC RESEARCH

APPLIED RESEARCH

PRODUCT DEVELOPMENT

TESTING

MAINTENANCE: PRODUCTIVE MAINTENANCE



AND REVIEWING SCHEDULED OVERHAULS CAN REDUCE TURBINE-GENERATOR DOWNTIME.

keep a turbine-generator on-the-line

General Electric's *Productive* Maintenance plan can help you reduce turbine-generator maintenance expenses. Here's how:

1) **Maintaining a supply** of General Electric spare parts can save valuable time. These parts fall into three categories:

a) Recommended parts such as thrust rings, springs for packing seals, brushes and brush holders, gaskets for control mechanisms, studs and nuts;

b) Optional spares such as rings for packing seals, bushings for control mechanisms, bearings and sealing rings for oil pumps; and

c) Major parts such as main bearings, rotors and stator bars.

G.E. can help you decide which to carry.

2) **By using General Electric renewal parts** and inspection service you get complete and accurate information about construction and engineering characteristics for your G-E unit. This means fast service and thorough engineering. General Electric is familiar with your machine and at the time of planning overhauls can suggest possible modernization.

3) **With the trend toward more uniform loads** throughout the year—both summer and winter—scheduling outages is becoming a real problem. Your General Electric turbine-generator representative can help you plan your overhaul schedule. By applying G.E.'s *Productive* Maintenance plan, and where operating conditions warrant, it may be possible to extend the time between overhaul periods.

You can get service 24 hours a day, seven days a week if necessary on your General Electric unit. The world's most modern turbine-generator manufacturing facilities and 46 G-E service shops are ready to help you.

Planning *Productive* Maintenance is just one of many areas in which General Electric is co-operating with electric utilities to prepare for tomorrow's load growth today. For more information write for bulletin GEA-6087. Large Steam Turbine-Generator Department, General Electric Company, Schenectady 5, New York.

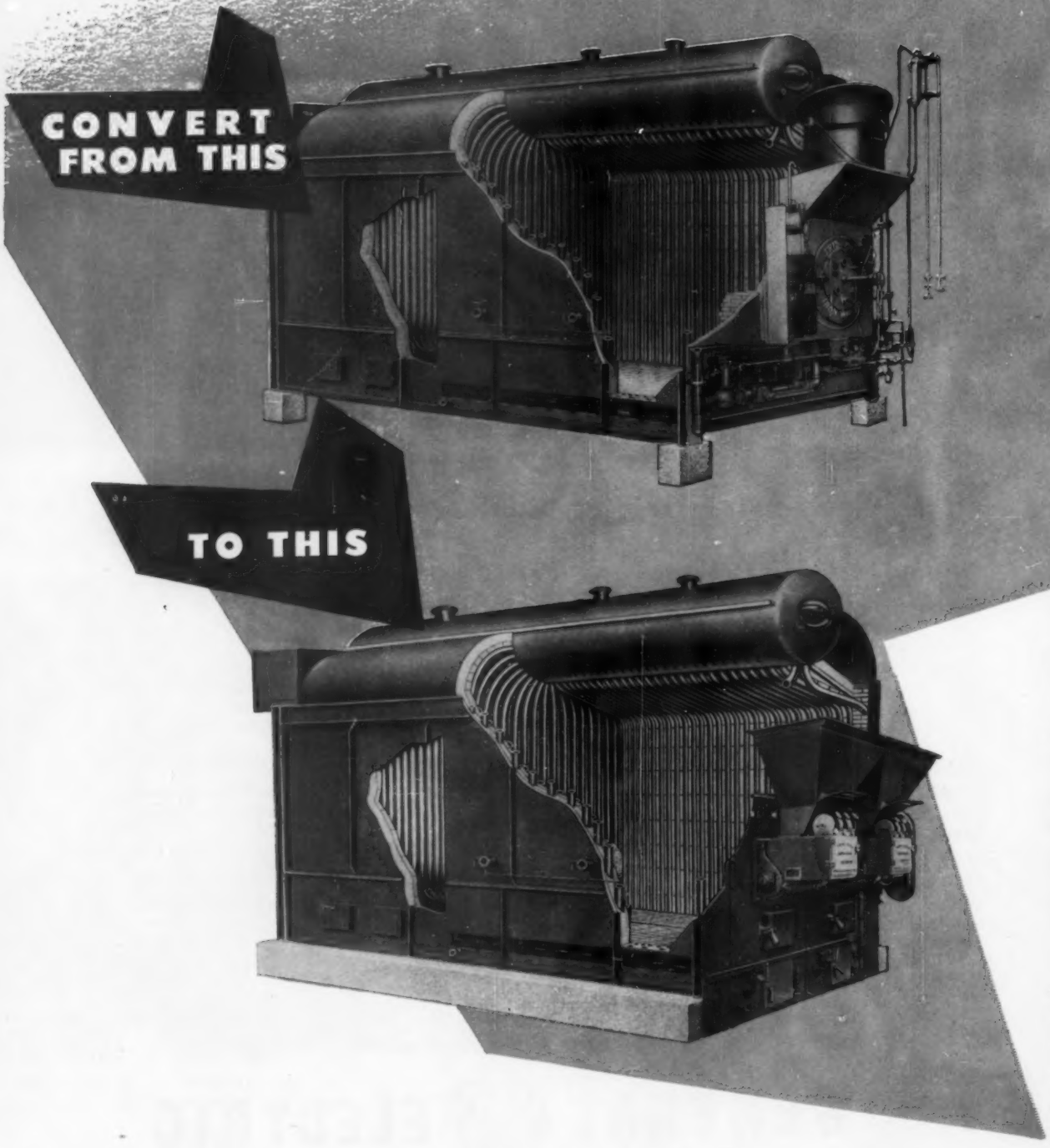
254-46

Progress Is Our Most Important Product

GENERAL ELECTRIC

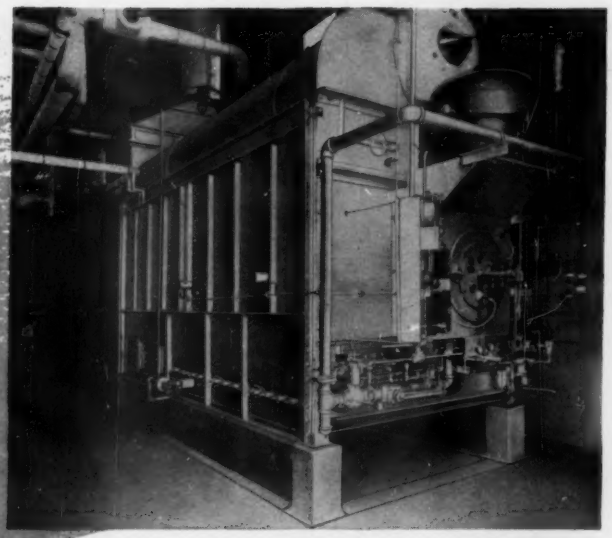
For more data circle 508 on Post Card

ERIE CITY



Packaged Boiler

OIL GAS *or* COAL FIRED



At Charleston Linen Service, Charleston, West Virginia, this Erie City 14,000 lbs/hr. VLP is now fired by Erie City oil and gas burner and will accomodate future stoker firing.

Is your plant ready to install a new package boiler? - - Then look to Erie City for the greatest range of sizes for all types of firing.

Your plant may be located in an area where gas, oil and coal are all available. At first you may want to fire your package boiler with gas and oil—but with the proper provision for future coal firing. The boiler for you to install is the Erie City VLP arranged for present oil and gas firing but with the furnace PROPERLY PROPORTIONED for future stoker firing. Erie City engineers will design your VLP for future conversion to either underfeed or dump grate spreader stoker. Then when you want to switch to coal firing pull out the burner and put into place the properly designed Erie City stoker. This guarantees you "undivided responsibility", for Erie City designs and manufactures a complete line of gas and oil burners and all types of stokers.

When arranged for gas and oil firing, the VLP will come complete with the most modern and effective safety controls and fully modulating, interlocked, electric controls, steam pressure actuated, guaranteeing proper fuel and air supply over the operating range of the unit.

All Erie City Package Boilers are completely factory assembled, piped, wired and Factory Tested with burner and fuel of your choice. They need only basic service connections in the field. For complete data write Dept. B.

ERIE CITY
116 Years in Steam Generation

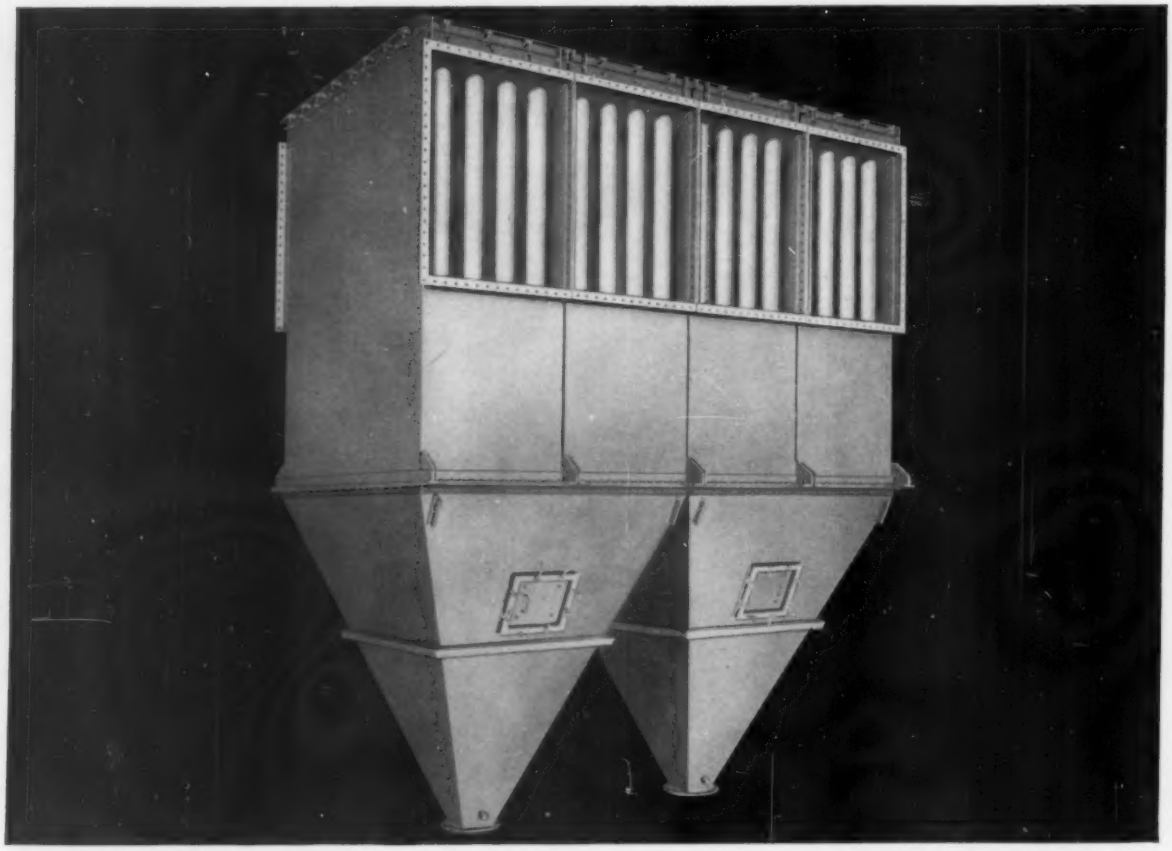
You can depend on Erie City for sound engineering

ERIE CITY IRON WORKS • *Erie, Pa.*

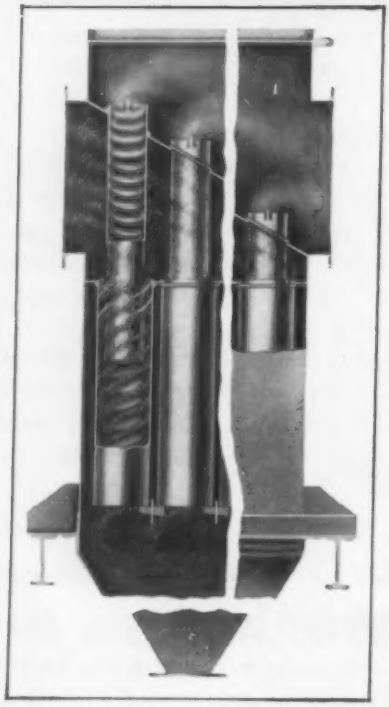
STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

For more data circle 509 on Post Card

Control fly ash with job-fitted



Series 342 Precipitator



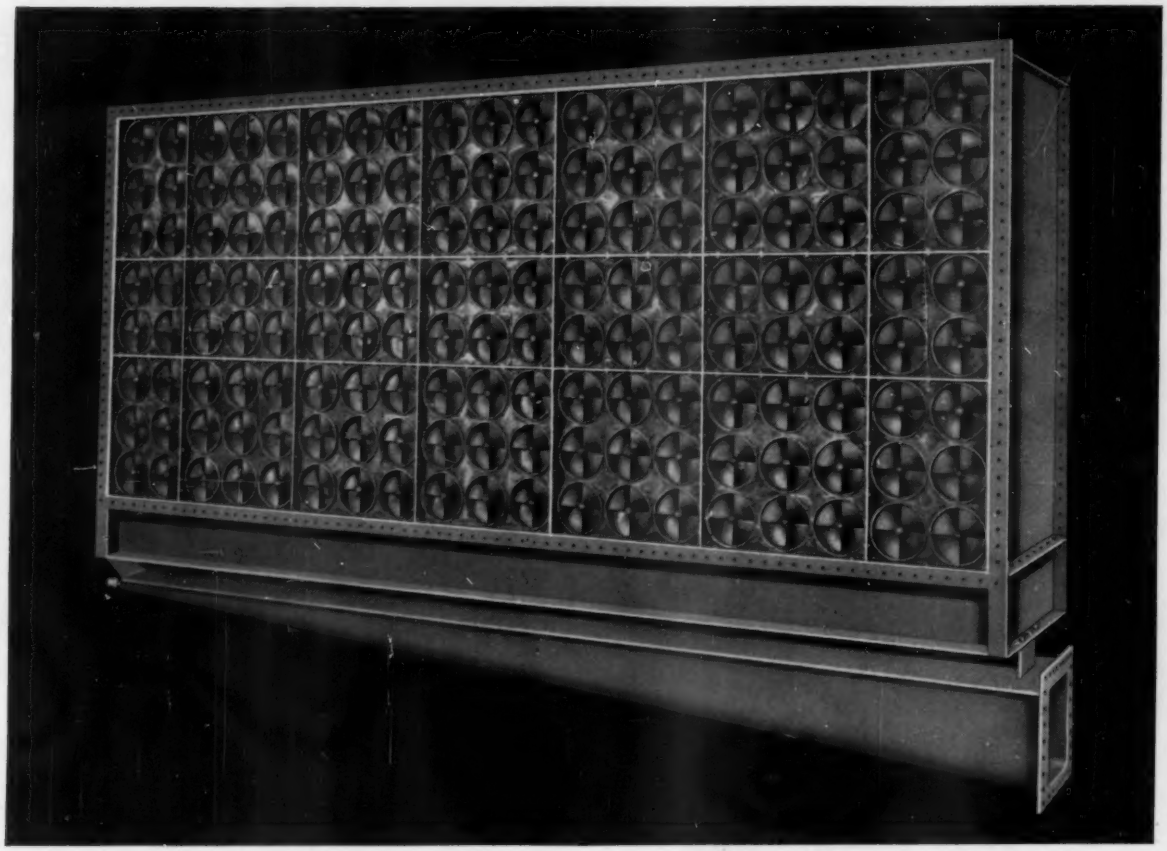
COMPACT DUST COLLECTOR – Series 342 Precipitator meets industry's need for a simple, compact, economical, all-purpose, mechanical-type dust collector. With the growing value of fly ash as a salable by-product, adequate, efficient collection is becoming increasingly important.

Easy to install because of its sectionalized construction, the Series 342 Precipitator has proved effective in controlling dust discharge to the atmosphere in a large percentage of industrial plants. The reason: since each tube assembly is basically an individual cyclone or centrifugal dust collector, the multi-tube Series 342 will deliver an over-all performance comparable to the high efficiency obtained by a single, small-diameter cyclone.

Furthermore, American Blower Series 342 Precipitator features welded-steel construction and removable tubes, is available in a variety of sizes to meet specific job requirements on either new or existing installations.

Dust-laden air or gas enters inlet plenum; gravity and centrifugal action force dust downward, adjacent to tube wall; dust is skimmed into gas-tight receptacle; cleaned air or gas moves upward through outlet tubes to outlet plenum.

American Blower precipitators

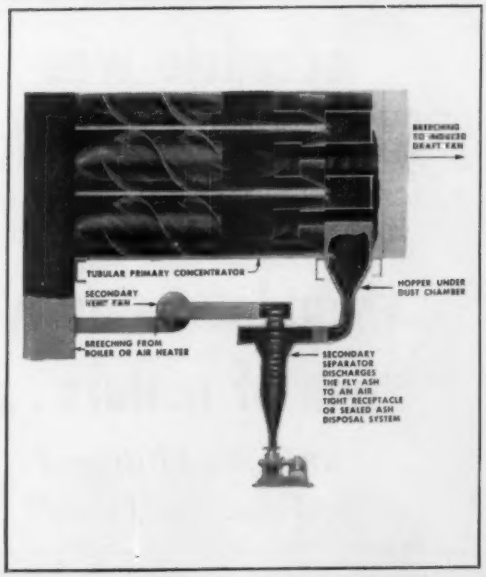


Series 361 Fly Ash Precipitator

FOR LARGE PUBLIC UTILITIES – Series 361 Fly Ash Precipitator offers maximum collection efficiency over entire operating range, occupies minimum space, and gives reliable performance, trouble-free operation.

What's more, the secondary separating system of the Series 361 makes it relatively more efficient at reduced loads when fly ash is finer and more difficult to remove. Then, too, ability to vary number and arrangement of individual cells makes it easy to tailor unit to the particular job.

Whatever your dust-collection problem, it will pay you to talk to an American Blower engineer. His knowledge of the application of precipitators and dust collectors can prove invaluable to you. Call your nearest branch, or write: American Blower Corporation, Detroit 32, Michigan. In Canada: Canadian Sirocco products.


TUBULAR PRIMARY CONCENTRATOR
SECONDARY VENT FAN
BREECHING FROM BOILER OR AIR HEATER
HOPPER UNDER DUST CHAMBER
SECONDARY SEPARATOR DISCHARGES THE FLY ASH TO AN AIR TIGHT RECEPTACLE OR SEALED ASH DISPOSAL SYSTEM

Secondary system results in velocity-efficiency characteristics which automatically maintain maximum efficiency over entire boiler load or operating range. Properly installed and operated, unit's collection efficiency is from 85% to 90%.

AMERICAN BLOWER

Division of AMERICAN-Standard

For more data circle 510 on Post Card

JAMES E. DAVIS CHIEF ELECTRICIAN
NORTHWESTERN GLASS CO.

"Our Production schedule was frequently disrupted by needless shutdowns on a line of motors . . *until we changed to Fusetron Fuses*"

James E. Davis,
CHIEF ELECTRICIAN, NORTHWESTERN GLASS COMPANY
SEATTLE, WASHINGTON

"Ordinary 500 amp. renewable fuses were blowing frequently in a 1000 amp. switch that controls a line of motors ranging in sizes up to 150 hp.

"We work on a tight production schedule, so these shutdowns with men and motors standing idle were costing us a considerable amount of money and trouble.

"As chief electrician, the problem was 'thrown in my lap'.

"A study of the situation indicated that harmless surges were causing the fuses to blow.

"We figured that the long time-lag of Fusetron dual-element fuses might correct the trouble.

"They were installed in 1953 and the original Fusetron fuses are still in service.

"We think this is quite a record because the switch is loaded to capacity 24 hours a day 7 days a week, only Christmas and July 4th excepted."

Here's why Fusetron Fuses give all purpose Protection

A fuse link combined with a thermal cutout - the result, a fuse with tremendous time-lag and much less electrical resistance and an interrupting rating in excess of 100,000 amps.

They have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to same dimensions as ordinary fuses. FUSETRON Fuses fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 amperes, both 250 and 600 volt types. Also in plug types for 125 volt circuits.

Their cost is surprisingly low.

Write for bulletin FIS.

THOMAS F. CURRAN
MACHINE OPERATOR

FOR LOADS ABOVE 600 AND UP TO 5,000 AMPS., USE BUSS HI-CAP FUSES . . .

They have unlimited interrupting capacity to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

Write for bulletin HCS.

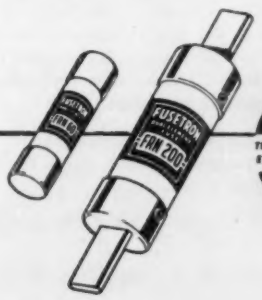
FUSETRON DUAL-ELEMENT FUSES DO MORE THAN ELIMINATE DOWN PERIODS CAUSED BY NEEDLESS BLOWS . . .

They Provide 10 Point Protection . . . .

1. High interrupting capacity — protect against heaviest short-circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes.
2. Protect against needless blows caused by excessive heating — lesser resistance results in cooler operation.
3. Protect against needless blows caused by harmless overloads.
4. Provide thermal protection — for panels and switches against damage from heating due to poor contact.
5. Protect against waste of space and money permit use of proper size switches and panels.
6. Protect motors against burnout from overloads.
7. Give DOUBLE burnout protection to large motors — without extra cost.
8. Protect motors against burnout due to single phasing.
9. Make protection of small motors simple and inexpensive.
10. Protect coils, transformers and solenoids against burnout.

Play Safe! install FUSETRON dual-element Fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!

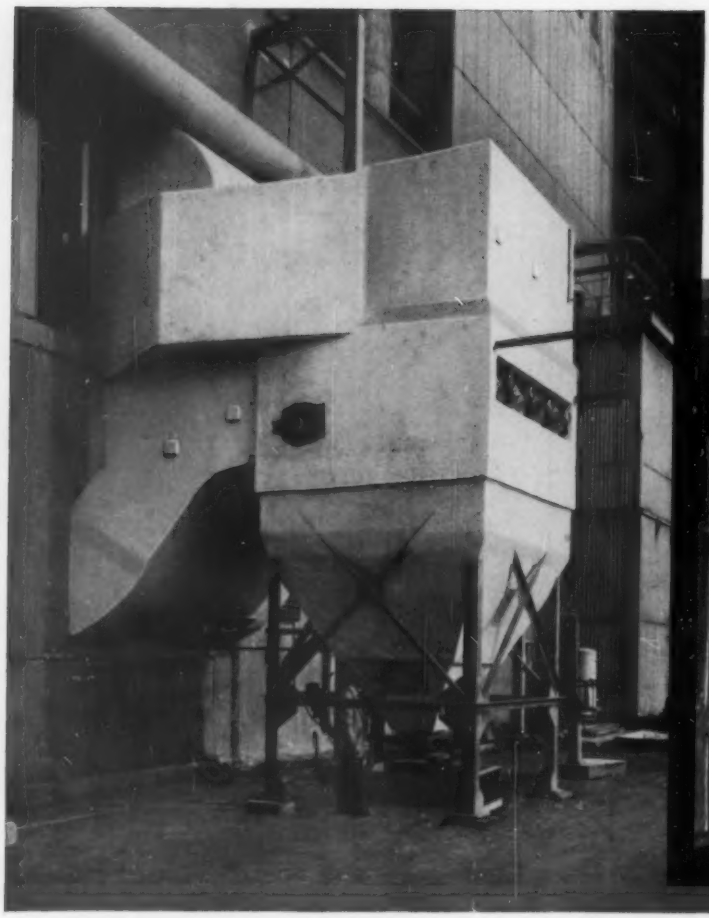
BUSSMANN MFG. COMPANY
(Division of McGraw Electric Co.)
UNIVERSITY AT JEFFERSON ST. LOUIS 7, MO.



FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

1155

For more data circle 511 on Post Card



This installation on boilers at Pittsburgh Coke and Chemical Company has been extracting 700,000 pounds of dust a month for the past year and a half, and the collector tubes show no sign of wear. Since the installation of this collector, one more has recently been ordered.

Detail of tube assembly. Note Hexagon shape of tops—there are no flat surfaces, it is impossible for dust to accumulate.

Tube erosion reduced to minimum in the HAGAN mechanical dust collector

Collection efficiency raised in 1 to 10 micron range

The new Hagan Dust Collector extends the scope of multiple tube collectors by means of a number of unique design features. The vaned nozzle inlet discussed on the opposite page is the key to the virtual elimination of tube replacement problems, and the greatly increased efficiency of the Hagan Dust Collector. Here are some of the many cost-saving features:

Tube erosion reduced to minimum. Hagan Dust Collectors are *guaranteed* against tube failure due to erosion *for two full years.*

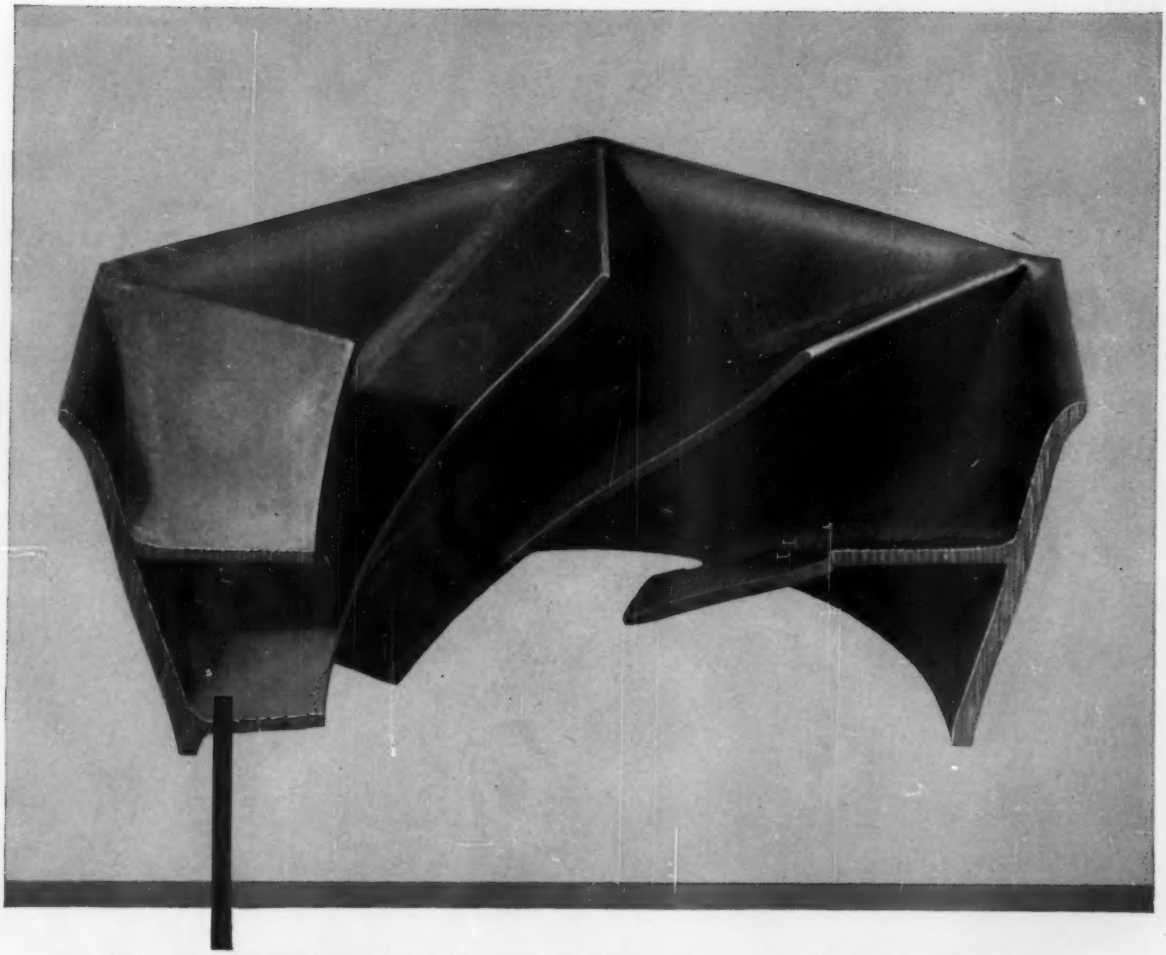
Fewer tubes—The Hagan Dust Collector employs a 6" tube. Intensive research, employing many different tube sizes (from 2" to 12"), established the six inch tube as yielding maximum efficiency together with greatest possible space saving.

Pressure drop 20% lower than conventional multiple tube collectors based on same efficiency.

Hexagon shaped tops—This shape permits close tube packing, eliminates dust trapping and clogging.

Easy maintenance—Ease of access to all parts makes the Hagan Dust Collector easy to inspect.

Write for Bulletin No. MSP 124-A for full description of the Hagan Dust Collector



SELECTIVE PARTICLE ACCELERATION

. . . key to prevention of erosion damage

This cutaway view shows in detail the unique shape of the inlet cell. Note that each vane is curved to follow the tube wall, and at the same time has a modified "S" shape. This curve was carefully designed to produce a smooth, even deflection of the air stream. The space between the vanes narrows from top to bottom, providing a controlled increase in air velocity. Result: Selective Particle Acceleration.

Smaller, lighter dust particles accelerate more readily, and spiral into the collector tube with a high initial velocity. The larger particles accelerate more slowly reaching a velocity sufficient for separation, but not enough to cause erosion. Both large and small particles are removed efficiently from the air stream.

This principle of Selective Particle Acceleration is an exclusive Hagan development, and has several specific advantages:

Long collector life, low erosion loss permits *two year guarantee* against erosion damage.

Collection efficiencies are increased, particularly in the less than 10 micron particle sizes, the area in which many conventional collectors *lose* efficiency.

Efficiencies maintained despite varying operating load conditions. The Hagan Dust Collector's effectiveness remains high even at 50% of rated capacity.

HAGAN CORPORATION

HAGAN BUILDING, PITTSBURGH 30, PA.

HAGAN

Systems and Components for: Boiler Combustion Control, Metallurgical Furnace Control, Process Control, Aeronautical Testing Facilities • Industrial Water Treatment • Chemicals for Water Conditioning

HAGAN SUBSIDIARIES: CALGON, INC. • HALL LABORATORIES, INC.

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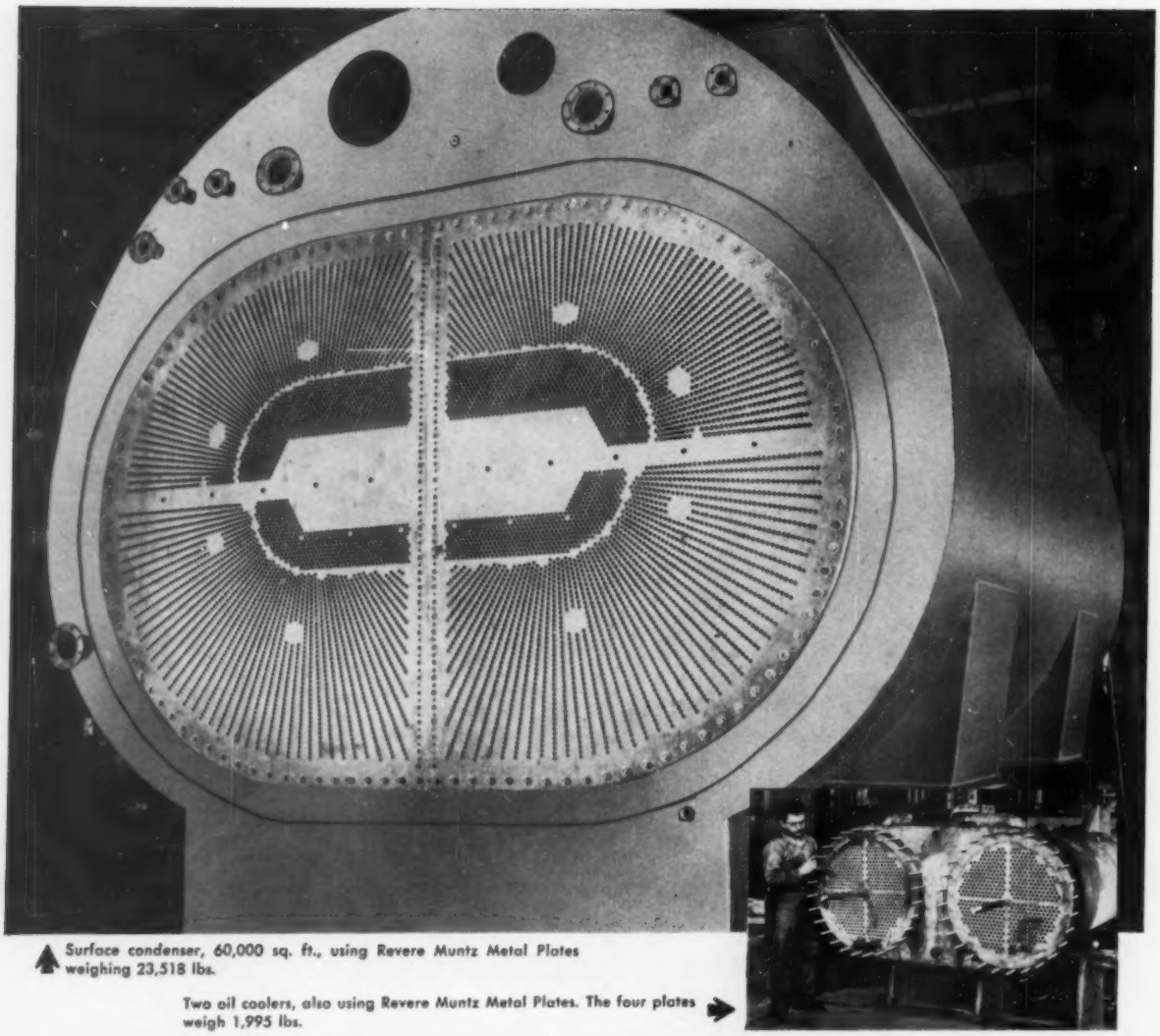


Surface condenser, 60,000 sq. ft., using Revere Muntz Metal Plates weighing 23,518 lbs.

Two oil coolers, also using Revere Muntz Metal Plates. The four plates weigh 1,995 lbs.

LARGE PLATES FOR CONDENSERS

. . . SMALL FOR OIL COOLERS

REVERE SUPPLIES THEM BOTH!

These two pictures offer a great contrast in the size of the equipment. The large condenser has 60,000 square feet of surface, the small oil coolers only 1,100 square feet. Both were made by Westinghouse Electric Corporation, Steam Division, Philadelphia, Pa., for the Columbus & Southern Ohio Electric Co., Columbus, Ohio. Revere supplied 23,518 lbs. of Muntz Metal plates for the condenser. There are four plates, 113½″ x 153″ x 1¼″ thick, hot rolled and leveled, cut to pattern. The oil coolers required four Muntz Metal circles, weighing 1,995 lbs. Two are 35¼″ in diameter and 1¾″ thick, and two are 31¾″ in diameter by 2″ thick. The units are for the utility's Picway generating station, for use with a 100,000 kw. turbo-generator.

Revere supplies condenser and heat exchanger plates and tubes in all the usual alloys, including not only Muntz Metal, but Admiralty Metal, Aluminum, Bronze and Brass, and Cupro-Nickel. The latter is especially advisable for difficult water conditions, such as salt, brackish or heavily contaminated water. Selection of the correct alloy to meet actual operating conditions may at times be a problem. Consult Revere. We will be glad to collaborate on such matters, and recommend the alloy most likely to serve long and economically. See the nearest Revere Sales Office.

FREE. Send for your copy of the informative booklet, "Life Extension for Condenser Tubes." Contains much basic technical as well as practical information for designers and plant operators.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

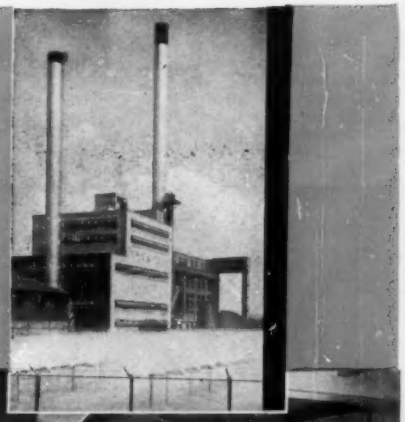
• • •

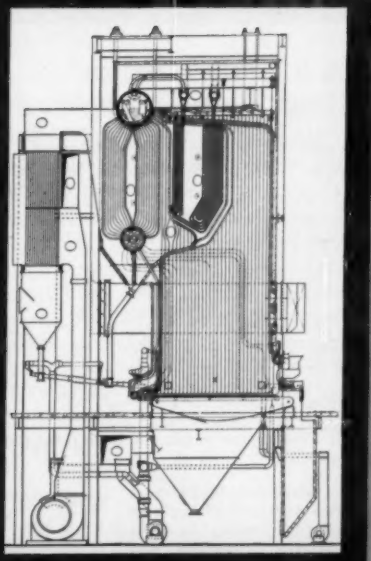
Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

For more data circle 513 on Post Card

Mile High Plant Steam Generator Fired By DETROIT ROTOGRATE STOKER

Southern Colorado Power Co.





Southern Colorado Power Co.
Canon City, Colorado
W. C. Porter, Vice President in Charge of Operations
Chester Huksy, Superintendent

Stearns-Roger Manufacturing Co., Denver
Engineers—Constructors
Loeb & Eames, New York, Consultants

This new unit which triples the capacity of the plant consists of a Babcock and Wilcox two-drum single pass steam generator fired by a Detroit RotoGrate Stoker having six feeders and distributors. The plant is at 5,300 feet above sea level. Capacity of above unit is 150,000 pounds of steam per hour at 860 psi, 915° steam temperature with preheated air at 350° F.

Design is based on bituminous coal:

B.T.U. per lb as fired	10,828
Moisture	8.84%
Volatile matter	33.72%
Fixed Carbon	44.69%
Ash	12.75%
Sulphur (separately determined)	0.7%

However, operation has been completely successful with coal from various mines in the vicinity.

Detroit RotoGrate is an exceptionally efficient spreader stoker with overlapping highly restricted grates that move slowly forward discharging ash at the front. Permits high burning rates with all Bituminous coals, Lignite or refuse fuels. *Write for Bulletin.*

DETROIT STOKER COMPANY

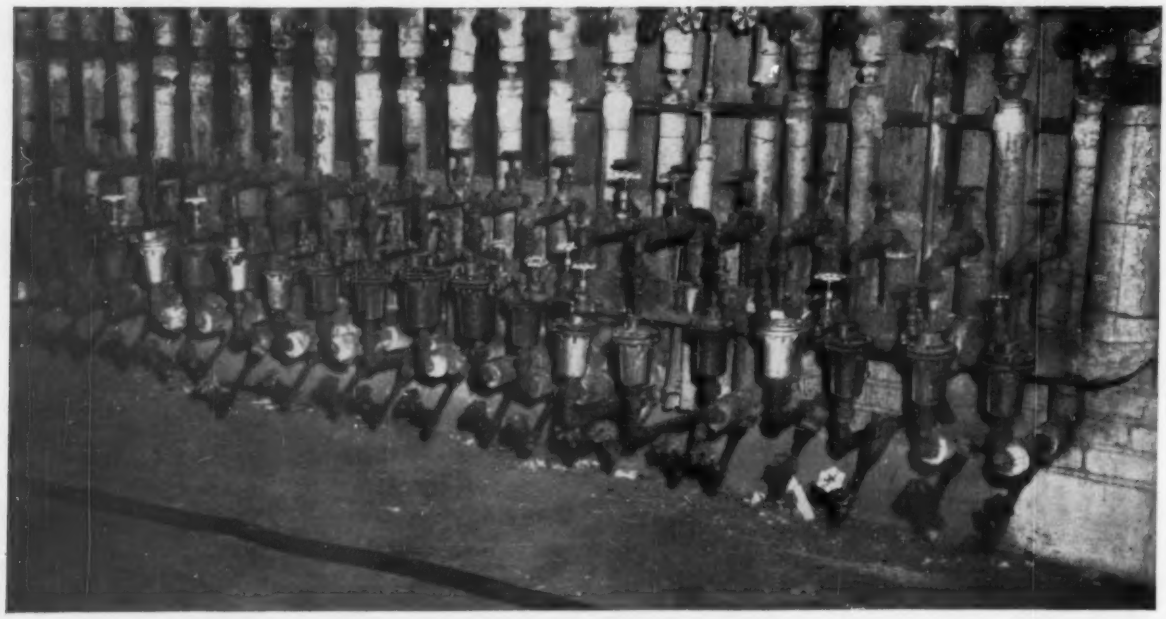
GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN

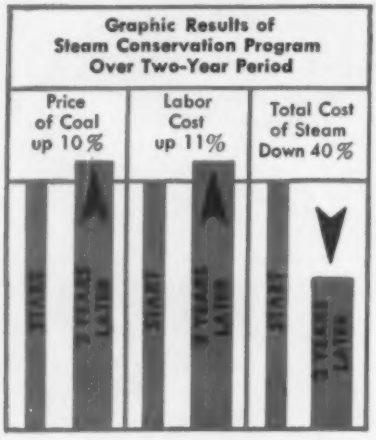
Works at Monroe, Michigan: District Offices in Principal Cities

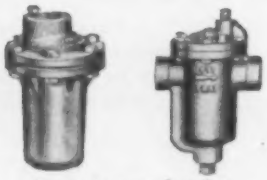
OTHER TYPES AND SIZES OF DETROIT STOKERS FOR EVERY INDUSTRIAL OR POWER NEED

For more data circle 314 on Post Card

How a Major Chemical Company Cut Steam Costs $100,000 Annually







Trap sizes and styles
for every condensate drainage job.

Armstrong Traps were a "Major Factor" in Steam Conservation Says Chief Engineer

Steam waste has a way of creeping up on you. Especially in older plants. The losses can make a staggering total.

Plants looking for a way to fight rising costs can well take a page from the 8-point steam conservation program that netted a major chemical plant $100,000 annual saving:

1. **Waste steam utilized** — all flash steam recovered for building heating.
2. **New steam traps installed** — Armstrong traps replaced old traps throughout the plant, indoors and out.
3. **Steam leaks repaired.**
4. **Insulation repaired.**
5. **All condensate recovered.**
6. **Steam piping simplified.**
7. **Steam turned off when not needed.**
8. **Preventive maintenance improved** to insure a continuous checkup on sources of waste.

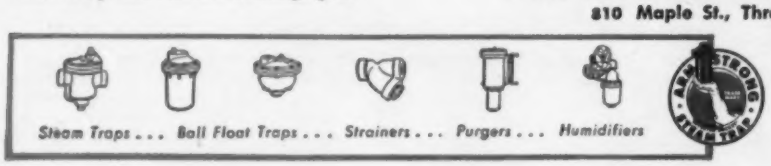
In commenting on the program, the Chief Engineer of the plant stated, "*4000 new Armstrong steam traps were one of the major factors in conserving steam. The traps, plus improved installation practice, have reduced annual trap maintenance parts and labor by $25,000 as compared to traps previously used.*"

Want all the facts? Tips on cost-saving standardized trap hookups? Facts about Armstrong traps? Ask for:

1. The No. 1, 1956 issue of the Armstrong Trap Magazine containing complete details, drawings and photos.
2. The 44-page Armstrong Steam Trap Book, a fact-full guide to better trapping.

Call your local Armstrong Representative or write:

ARMSTRONG MACHINE WORKS
810 Maple St., Three Rivers, Michigan



ARMSTRONG STEAM TRAPS

For more data circle 515 on Post Card

HELPFUL BULLETINS

VALVES, PIPING FITTINGS

101 Butterfly Valve Manual — Forty-pp Catalog B-2 is designed to help power engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes rubber seat butterfly valves from 4 in. diam up, for handling liquids and gases. Photos, drawings and diagrams amplify the text. The Henry Pratt Co.

102 Control Valves — Bulletin LB-2 is a well illustrated 12-pp booklet which gives details on construction and operating characteristics of Series LB control valves, available in sizes 1 through 4 in. Describes design and operation features and includes specifications and valve sizing data. Conoflow Corp.

103 Diaphragm Valve — Form 100, 12 pp, features descriptive and technical information on company's line of diaphragm valves. Describes valve design and valve material, basic methods of operation, applications, operational data and selection information. Tables of dimensions and dimensional diagrams are included. Hills-McCanna Co.

104 Air Valves — The design and application of air valves is treated in this 30-pp pocket-size booklet. Written in nontechnical language, it begins with the principle of valving as used in water faucets, and continues through the evolution of simple straight-way and poppet types actuated by air. Parts, structure and action of more complicated valves are also covered. Mechanical Air Controls, Inc.

105 Full Flow Valves — Bulletin 500 deals with eight types of full flow valves manufactured by this company. Standard materials and specifications are described and diagrammatic drawings illustrating operation and design features are included. Coppus Engineering Corp.

106 Safety and Relief Valves — Operating and design features of an all-purpose safety valve for steam generator service are described in Bulletin 730. Scope of design, general dimensions, parts and materials and capacity data are presented. Manning, Maxwell & Moore, Inc.

107 Prefab Piping — Catalog 100, 28 pp, describes prefabricated insulated piping systems (underground and overhead) for steam, condensate, hot or chilled water and other fluids. Covers design, applications, and installations of these systems and includes technical data. Designs for various requirements are listed — simple or multiple inner pipe, casings of flanged cast iron, flanged steel or welded steel. Step-by-step diagrams show on-the-job installation and photos of typical installations illustrate versatility of application. E. B. Kaiser Co.

108 Lined Pipe, Fittings — Fabrication techniques and technical information on applications of company's Lectro-Clad nickel-lined pipe and fittings are featured in this 8-pp manual. Photomicrographs illustrate pore-free and adherent characteristics of the nickel lining. A section, complete with engineering drawings, is devoted to welding procedures and general fabrication. Also given is technical information on use in paper and pulp industry, chemicals manufacturing, petrochemical industry, water systems, food industry. Bart Mfg. Corp.

INSULATION

109 Pipe Insulation — This 40-pp catalog was designed as a reference guide to company's pipe insulation, presenting a new way to specify proper thickness for pipe insulation, based on the "J" factor. This special index eliminates complicated computation formerly required to determine economical thicknesses. The book also features detailed drawings that show how single-layer insulation is applied to various vertical and horizontal expansion joints as well as to pipe bends, flanges, valves and fittings. Charts and tables list physical and thermal characteristics. Union Asbestos & Rubber Co.

110 Pipe, Block Insulation — Form A-401 is a 6-pp bulletin describing advantages of 85 per cent magnesia pipe covering and block insulation. Applications are listed, and recommended thicknesses and other technical data are tabulated. The Eagle-Picher Co.

111 Pipe Insulation Tape — Techniques for protecting underground pipe from corrosion with "Scotchrap" brand pipe insulation tape is the subject of this 24-pp booklet, "Tape It Easy." It provides step-by-step photos and instructions for wrapping bends, elbows and short sections, patching pipe with tape, preparing joint surfaces for wrapping, wrapping welded joints and taping straight pipe sections as well as street "T" fixtures and other fittings. A summary of suggestions on pipe protection is included, as well as a coverage table listing recommended tape overlap, other data. Minnesota Mining and Mfg. Co.

MECHANICAL POWER TRANSMISSION

112 Fluid Drives — Sixteen-pp Bulletin 9119 covers Gyrol fluid drives for ½ to 25 hp applications, including Types T, TM and VS Class 2 units for industrial use in the low horsepower range. Explains fluid drive principle and outlines advantages of the units. Typical performance curves showing starting torque, starting current and heat generation characteristics, and other charts showing typical adjustable speed torque curves are included. Selection tables are provided, as well as installation type drawings. American Blower Corp.

113 Speed Reducers — Twelve-pp Bulletin 191 describes company's line of gear motors, separate motor reducers, and speed reducers. Design advantages are detailed through description, photos and drawings, and a large cutaway view showing component parts is included. Factors in speed reducer selection are also covered. Sterling Electric Motors.

114 Speed Reducers — Booklet B-6727 is a 46-pp speed reducer engineering manual which presents complete application information such as hp ratings, torque capacity, overhung load values, dimensions, construction features, installation and maintenance for single, double and triple reduction. Engineering data is given in tabulated form, and dimensional diagrams, photos and cutaway views are included. Westinghouse Electric Corp.

115 Hydraulic Fan Drives — Bulletin 3009 describes company's hydraulic fan drive for air-cooled heat exchangers and cooling towers. Detailed information on the IMO motors and pumps and the worm gear reducers that make up the fan-drive unit are included, as well as performance curves useful for selecting the right unit for specific applications. De Laval Steam Turbine Co.

116 Grommet V Belts — Construction features of the "Texrope" grommet V-belt are described in Bulletin 20B6497C. Advantages are detailed and design and construction features are illustrated with cutaway drawings and photos. Allis-Chalmers Mfg. Co.

117 Flexible Chain Couplings — Catalog C45–56, 16 pp, contains specifications, dimensions, ratings and application on series DSC, series SA silent chain couplings and series DRC roller chain couplings. Pertinent information is also tabulated on stamped steel covers, plastic covers and others. Morse Chain Co.

TUBING

119 Flexible Plastic Tubing — Bulletin T-97, 28 pp, covers Tygon formulation individually and in technical detail. Applications and limitations of each of these plastic formulations are presented, and physical properties and chemical resistance based on ASTM testing methods are given in charts and tables. Typical tubing applications are illustrated, and bore and wall combinations, available lengths and packaging data are presented. Plastics and Synthetics Div., The U. S. Stoneware Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 134 and 135.

120 Tubing System Tips — Catalog File 4305, 8 pp, contains information, including charts and tables, to aid in selection of tubing as to size, wall thickness and material for various operating conditions. Factors considered are flow requirements, pressures, severity of service and temperatures. Tube & Hose Fittings Div., The Parker Appliance Co.

121 Cabled Tubes — Bulletin 356, 12 pp, gives complete information on various types of cabled tubes for instru-

ments and controls and methods of installation. Illustrations show regular copper and polyethylene tubes, as well as four corrosion-resistant types. Method of utilizing armored cable instrument tubing to provide better protected instrument lines at lower cost is detailed, and complete data is included, as well as instructions for handling under all possible conditions. Crescent Insulated Wire & Cable Co.

ELECTRICAL

122 Explosion Proof Motor — Latest design features of company's explosion-proof motors in NEMA rerated ratings of ½ to 30 hp (Type GZZ) and in non-rerated ratings of ½ to 100 hp (Type APZZ) are described in Bulletin 51B7286G. In addition to cutaway views of the motor, bulletin includes tables of ratings and dimensions as well as a horsepower frame chart. Allis-Chalmers Mfg. Co.

123 Fractional Horsepower Motors — New developments in fractional horsepower motors and gear reduction units are shown in this 16-pp catalog. It also describes a complete line of speed reduction units, in open or closed type and single or double reduction. Dimensional diagrams and specifications are included. Rae Motor Corp.

124 Induction Motors — Bulletin 05r88123A describes a line of large two-pole squirrel-cage induction motors, 900 hp and larger, designed to meet requirements of today's high speed drives. Construction details and applications are covered, and a large cutaway view is used to highlight important features. Allis-Chalmers Mfg. Co.

125 Fan Cooled Motor — Latest design features of company's totally-enclosed, fan-cooled motors in NEMA rerated ratings of ½ to 30 hp (Type GZ) and non-rerated ratings of ½ to 100 hp (Type APZ) are described in 6-pp Bulletin 51 B7225D. In addition to cutaway views of motor, bulletin includes tables of ratings and dimensions and a horse-power frame chart. Allis-Chalmers Mfg. Co.

126 When Disaster Strikes — Twelve-pp Bulletin GEA-6484 tells how company's apparatus service shops can help speed plant recovery following emergencies. Bulletin describes procedures for recovery of vital electrical equipment damaged by flood, fire, water, wind, and other natural forces. Suggestions serve as a guide in helping industries and utilities resume production quickly — prior to contacting the service shops. Includes such topics as basic electrical steps toward restoring production and recommended procedure for reclamation of high-priority electrical equipment. General Electric Co.

127 Circuit Breakers — Bulletin 3411, 20 pp, covering general purpose circuit breakers of the hydraulic-magnetic type describes in detail hydraulic-magnetic principle, design, operation, and application of this circuit breaker. Schematic diagrams, time-delay curves, and other engineering information are included. Data on basic design considerations, voltage drop curves, interrupting capacities and similar information is also covered in tabular or graphic form. Wiring diagrams on dimensional drawings illustrate special circuit forms. Heinemann Electric Co.

128 Circuit Breakers — Six-page Bulletin 1004-A describes company's line of circuit breakers, including manually and electrically operated circuit breakers to be applied as switchboard breakers, individually enclosed breakers, one-high individually enclosed drawout units, and heavy-duty d-c circuit breakers. Cutaway view illustrating component parts is included, as well as a table of ratings. I-T-E Circuit Breaker Co.

129 Air Interrupter Switch — Bulletin 100, 8 pp, provides full details on company's high voltage air interrupter switch. The comprehensive description includes case and cutaway photos, multiple position illustrations, dimensional drawings, typical specifications and examples of built-in installations. Cutaway photos illustrate three front-operated types available and photos showing installation procedure are included. Continental Electric Equipment Co.

130 Static Switching Systems — Bulletin GEA-6364, 8 pp, describes operation of a static switching system and lists advantages as reduced downtime, easy maintenance, reliability, flexibility, reduced inspection and replacement, and minimized atmospheric problems. In discussing areas for applying static switching systems, bulletin cites operations in which dependability, a high degree of automation, frequent operation, or maintenance under severe atmospheric conditions is an important factor and recommends this contactless control for such application. General Electric Co.

131 Battery Charger — Bulletin GEA-3179D illustrates and describes phano-chargers — adjustable self-regulating electronic battery chargers for maintaining storage batteries. Discusses operation, cites various advantages of the unit, and covers construction details with photos and text. Performance curves and a schematic diagram are included. General Electric Co.

132 Replacement Capacitors — This company's 1957 Replacement Capacitor Catalog 200D-3, 44 pp, covers electrolytic, paper tubular, industrial, mica, ceramic, filter and motor start capacitors. Catalog is sectionalized and thumb-indexed for quick reference. Complete engineering data on the various types of capacitors are presented in tabulated form, and photos and drawings are used to illustrate features of operation and design. Cornell-Dubilier Electric Corp.

133 Porcelain Insulators — Catalog 53, 66 pp, details general engineering data for purified porcelain insulators and includes the latest EEI and NEMA standards, as well as a presentation of company facilities for manufacture of porcelain to customer specifications. Covered in the catalog are pintypes, guy strains, spools, line posts, suspensions, switch and bus insulators, malleable, forged steel and aluminum hardware and a line of indoor switch and bus supports. Victor Insulator Div., I. T. E. Circuit Breaker Co., Inc.

134 Terminal Blocks — Condensed Catalog 556, 8 pp, features company's entire line of terminal blocks and terminal block kits. Technical description, specifications and current prices are included, accompanied by a selector chart designed to pin-point best block for application. Curtis Development & Mfg. Co.

LIGHTING

135 Illumination Design Data — Basic reference data on interior lighting installations is contained in 44-pp Manual A-4854, which features a section describing footcandle levels required for each group of seeing tasks. These levels are then related to many kinds of rooms and areas. A chapter on interior lighting design describes ways of calculating quantity of light for an area and covers such subjects as selection of lighting systems, maintenance factors, and location of luminaires. A series of tables minimize mathematical calculations necessary, and other tables provide data on ballasts and fluorescent, incandescent and mercury lamps. Westinghouse Electric Corp.

136 Lighting Reference Aid — Descriptions, illustrations and lighting data on 394 industrial fluorescent lighting units manufactured by the company are featured in 36-pp Bulletin B. Among the units listed are lighting systems for the proper illumination of all types of plant work areas; from general lighting to critical seeing tasks, from damp, humid atmospheres to hazardous locations where explosive dust may be in the air. An easy-to-follow arrangement speeds up and simplifies reference according to reflector types, lamp types, accessories, construction and lighting data, and the bulletin includes a tabulation of coefficients of utilization. Benjamin Electric Mfg. Co.

INSTRUMENTS AND CONTROLS

138 Instrumentation Bibliography — Bulletin G-2 is a 20-pp index of instrumentation literature offered by this company. It covers catalogs, bulletins, specification sheets, data sheets, illustrated lectures and articles from Instrumentation Magazine. Information on how to obtain this literature is given. Minneapolis-Honeywell Regulator Co.

139 Temperature Controls — Catalog MC-135, 6 pp, describes company's temperature controls, with physical specifications, performance data, temperature ranges and other pertinent information on these precision thermostats. Also listed and described are modifications and special features, such as moistureproof seals, armored cable, extended shell, temperature-setting knob and dial, which can be supplied to adapt the controls to varied service requirements. Fenwal Inc.

140 Recorder-Controller — A new approach to recording, indicating and controlling instruments required in industrial processing is described in Bulletin F-103. Instrument systems featuring four basic components that can be interchanged to perform a variety of functions, as well as minimize maintenance problems, are fully described, and photos, drawings and specifications included. Fielden Instrument Div., Robertshaw-Fulton Controls Co.

141 Recording Controllers — Bulletin 979 describes two of company's pressure and temperature control products, a pneumatic recording controller and a recorder. Full technical specifications are included, as well as dimensional data and other information. The A. W. Cash Co.

142 Remote Reading Gages — Eight-pp Catalog 291, revised, shows new designs in remote reading liquid level gages, including the Red Flasher Truscale. This has a scale which flashes continuously in red for a positive warning when boiler water level gets too high or too low. Profusely illustrated with photos and

how would you like to add $250,000.00 to your profit?

Dowell Chemical Cleaning Made This Possible for an Industrial Plant!

In 1954 an East Coast plant employed Dowell Chemical Cleaning Service on a limited basis. The results were encouraging.

In 1955 the same company expanded its use of chemical cleaning. The results were startling. More throughput, less down time, and greater overall plant efficiency effected nearly a *$250,000.00 saving!*

In 1956 the program was continued. The result: still more savings. Eventually, chemical cleaning on a continuing year-around basis is expected to effect savings of from $300,000.00 to $500,000.00 annually.

This case history is about an oil refinery. However, Dowell has eye-opening performance data to show you in almost any industry.

Dowell engineers are experts in the use of solvents to remove scales and sludges—those deposits that cut the capacity of process and steam generating systems. Dowell does the job for you and furnishes all necessary chemicals, trained personnel, pumping and control equipment.

For additional information, call the Dowell office near you. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

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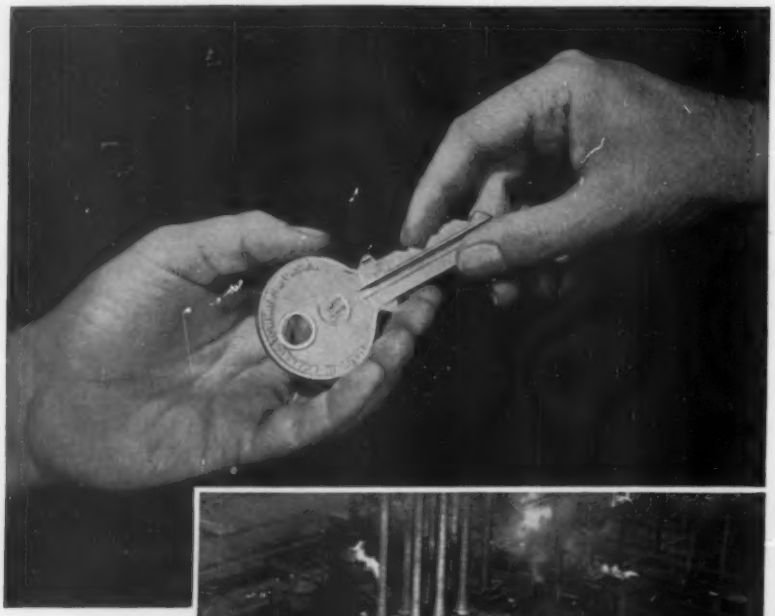
WHY A TURN-KEY PROJECT IS BEST FOR YOU



Ford's Rouge Power Plant

A Turn-Key project is a "packaged" service that combines engineering and construction in a single contract . . . and that may include other services such as preliminary investigations, studies and site selection, procurement of materials and equipment, initial operation of the finished plant.

Advantages to you:

LESS COST: Who is better qualified to construct a project than the firm that designs it? In a Turn-Key project one organization performs both engineering and construction services; details are handled quickly, efficiently—therefore more economically.

LESS TIME: Excavation can be made and foundations started several months prior to the release of the Engineer's completed design drawings and specifications. Construction follows blue prints—promptly. This scheduling of design and procurement to meet construction requirements permits the project to advance in an unbroken sequence—setting the stage for a faster delivery of the completed plant.

MORE SERVICE: One contract gives you *complete* service—no question about responsibility. Thus you have better control and more closely integrated planning.

We offer you engineering and construction services separately but suggest you consider combining them into a Turn-Key project that will save you both time and money. Write today for this free booklet describing the advantages in detail.

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engineering drawings, catalog covers gages in four pressure groups from under 900 to over 1500 psi. Jerguson Gage & Valve Co.

143 Process Control Instruments — Catalog 505, 16 pp, describes pneumatic instruments for process control, including indicating pilots, transmitters and receiver gages. Specifications are detailed and design features are described and illustrated. Measuring elements for pilots and transmitters are covered, and other descriptive and graphic detail is included. United States Gauge Div., American Machine and Metals, Inc.

144 Panel Control Systems — Fireye Series AC panel control systems for automatic oil, gas, and combination burners are described and pictured in 16-pp Bulletin CA-22. Contains full information on each packaged control system for both commercial and industrial burners, and includes application, operation and component data, as well as dimensions. A concise selector guide is also presented. Individual components, standard with these systems, are described and identified, and optional equipment is listed and illustrated. Combustion Control Div., Electronics Corp. of America.

145 Water Gage — Bulletin WG-1814, 6 pp, describes company's ColorPort water gage for high pressure boilers (up to 3300 psi). Bulletin gives full details on gage's design and operation, and shows how port-type arrangement and two-color readings give greater visibility and greatly reduced maintenance requirements. Additional features are described, installation sketches included. Yarnall-Waring Co.

146 Annunciator Systems — Standard, integrated Panalarm annunciator systems for industry are illustrated and described in 32-pp Catalog 100B. Discusses company facilities, annunciator function and general features of the systems, typical industry applications, and presents operating sequences, enclosures, mechanical specifications, technical data and performance features of specific types of systems, available remote equipment and components, ordering information. Panalarm Div., Panellit, Inc.

147 Photoelectric Controls — Bulletin PA 561, 24 pp, tells how photoelectric controls provide simplicity in industrial automation and describes design, construction, installation and maintenance advantages. A large chart facilitates selection, listing applications, operating range, characteristics. Controls for various industrial purposes are covered, and specifications, dimensional diagrams and photos are included. Photoswitch Div., Electronics Corp. of America.

148 Control Devices — Bulletin GEA-6317 is a 12-pp publication describing application features of company's control devices built to meet JIC standards. Illustrated bulletin gives product data on the machine tool relay, oil-tight push button, solenoid, limit switch, magnetic starter, plugging switch, and pneumatic time-delay relay. General Electric Co.

MAINTENANCE

149 Cleaning Compounds, Solvents — This 8-pp, illustrated bulletin gives detailed information and applications of chemicals for every industrial cleaning requirement. Products covered include a liquid steam charge for light

Hall Industrial Water Report

VOLUME 4 DECEMBER 1956 NUMBER 6

Water Detectives—Industry's Protection Against Loss From Boiler Outages and Costly Repairs

Sources of immediate and potential trouble are easily recognized by engineers skilled in water technology and long experienced in boiler plant operation. Hall Laboratories, Inc. has been providing this detective service for their clients for more than thirty years.

Tube Failures Caused By Low Oxygen!

On his initial visit to a plant in Northern Michigan, Hall engineer C. H. (Buck) Turner found a heavy accumulation of loose iron oxide in two 600 psig boilers.

The history of occasional failure of wall tubes due to overheating and/or thinning indicated that the iron oxide was coming from the boiler metal.

Since all evidence pointed toward an overloaded boiler, Turner recommended that steam flow studies be conducted, but these studies revealed that the boilers rarely reached their designed capacity and normally were at 75 percent or less.

Pondering this anomaly of overloaded tubes in an underloaded boiler as he approached the plant one day, Turner's attention was drawn to the plant's stacks which appeared "hot" and very dark. From experience, Turner knew this meant an extreme load or improper combustion.

Immediate questioning revealed that the carbon dioxide recorders were out of order, but spot checks had indicated carbon dioxide values in the flue gas of over 17 percent. The reported reason for this was that the economizer passes had become filled with ash and the induced draft fan could not handle the combustion gases and air required, even for a moderate load.

Turner knew that high carbon dioxide and periodic positive pressure in the furnace meant high furnace temperatures and that this could mean an overloaded furnace in an underloaded boiler.

Proof of the validity of Turner's conclusions was supplied by operating results following the cleaning of the economizer gas passage with "wet" water. No more iron oxide and a cessation of failures even in seriously thinned water walls. The title is not a misprint. The flue was the clue that low oxygen in the combustion zone had caused the tube failures.

Carryover From Faulty Steam Drum Internals

On one of his periodic service visits to a paper company plant near Pittsburgh, Hall staff engineer Doug Noll was told that a throttle valve on a variable speed steam turbine was sticking because of deposit on the valve stem.

Carryover due to unsatisfactory water conditions was not considered likely since past troubles with variable water levels and foaming had been overcome with the feed of Hagan C-1 Antifoam®. Therefore, Noll decided that the difficulty was due to something mechanically wrong in the steam drum of the boiler supplying steam to this turbine. He proved this with steam purity tests which showed 3-5 ppm of solids in the steam from this boiler and only 1 ppm of solids in the steam from another boiler.

At the first opportunity, Noll, together with the plant men, inspected the suspect boiler. They found the curtain baffle in the steam offtake drum had dropped because of loose bolts. This permitted wet steam to short-circuit from steam circulating tubes to the steam offtake. Inspection also revealed a leak in the feedwater line which could have contributed to the trouble.

The drum internals were repaired and further testing showed steam from the boiler to contain less than 1 ppm of solids. The throttle valve is again functioning properly.

Mischief Caused By Idle Boilers

The engineers in Hall's St. Louis office were really shocked one morning when they received a call from a well satisfied client of long standing complaining about the internal condition of the boilers. Hall engineer Bill Pfeiffer left immediately for the plant to see what could have happened.

Hagafilm® was being fed to prevent condensate line corrosion and the plant personnel felt that this was removing old corrosion products and returning them to the boilers where they adhered to the boiler surfaces. Not convinced that this was the case, Pfeiffer collected samples of the deposit for analysis by Hall's Pittsburgh laboratories. The analysis indicated process contamination.

Pfeiffer checked condensate from all sources but found no contamination. However, the plant operated on a five-day week and Pfeiffer suggested that condensate samples from all sources be collected again early Monday morning when the steam was first turned on.

An amazing amount of emulsified oils, bonderizing solution and highly alkaline material was found in the condensate because of leakage into heating coils when the steam pressure was reduced for the week-end. Repairs were made immediately on the various coils and condensate contamination was stopped. The plant is once again enjoying trouble-free operation of the boilers.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

Water is your industry's most important raw material. Use it wisely.

Hall Laboratories, Inc.—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

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ROTOJET®
Tube Cleaners

Clean tubes and pipes from ½" to 12" I.D. THOROUGHLY QUICKLY

ROTOJET Model 512 Air-driven Motor, universal joint, swing-frame head, and solid brush.

Our large stock of Rotojet air-driven and water-driven tube cleaners, accessories, and repair parts for straight and curved tubes, pipes, and transfer lines is available to meet most requirements without delay. Tube cleaner specialization for 43 years assures satisfactory results from any Rotojet equipment we recommend. Send for Bulletins J-410 and R-105. For quick action wire or phone, HUmboldt 3-0570.

ROTOJET Model C-525 Air-driven Motor with swing-frame head and universal joint.

ROTOJET Model C-526 Air-driven Motor with pivot head and universal joint.

ROTOJET Junior Model S32 Air-driven Motor, universal joint, cone cutter.

ROTOJET Junior Model C434 Air-driven Motor, flexible coupling, expanding brush.

ELLIOTT COMPANY - ROTO DIVISION
Tube Cleaner Specialists Since 1910
147 Sussex Avenue, Newark, N. J.

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and medium-duty steam cleaning, an emulsifiable liquid concentrate for cleaning and degreasing metal and concrete surfaces, a rust and scale solvent, and a liquid cleaner for cleaning corrosion, pit marks and oxidation from aluminum. Brulin & Co., Inc.

150 Floor Stain Removal — "It's easy when you know how," can best describe this 8-pp illustrated booklet on how to remove stains from floors. Features easy directions telling what to do and what to avoid, what materials are needed and how to get them. First steps for general stain and spot removal from all floors are given, and then separate, specific instructions for soft floors, like asphalt tile, mastic, rubber, wood, cork, linoleum and magnesite, and for hard floors like concrete, marble, terrazzo, ceramic tile are listed. Huntington Laboratories, Inc.

WATER TREATING

151 For Boiler Protection — Scav-Ox, a 35 per cent hydrazine solution for removing dissolved oxygen from boiler feedwater, is described in this 16-pp illustrated booklet. It covers in detail the use of the solution for protecting low, medium and high pressure boilers, discussing determination of dosage, recommended methods of application, testing methods for hydrazine, and properties and handling of the material. Comprehensive operating data are presented in the form of case studies. Olin Mathieson Chemical Corp.

152 Feed Water Treatment — The need for boiler feed water treatment is discussed in this informative bulletin. How the company solves the problem, and advantages in terms of operation and economy detailed. Western Chemical Co.

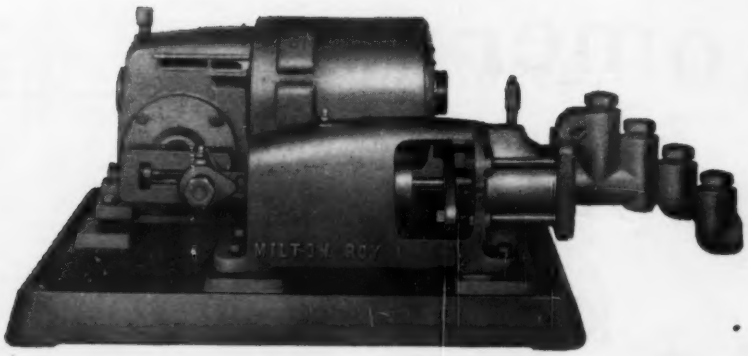
153 Water Softeners — Publication 4801-A describes the versatility and economy of company's hot lime-zeolite softeners which are designed to provide zero hardness boiler feed water. Bulletin details method of operation, expected results, chemical savings and simplicity of operation. Cochrane Corp.

154 Chemical Feeder — Bulletin 340-A features chemical feeding equipment for use in the treatment of waters and wastes. Lists advantages of the compact solution feeder which incorporates either one or two positive displacement diaphragm pumps, describes operation, and offers suggested specifications. Infilco Inc.

OTHER EQUIPMENT

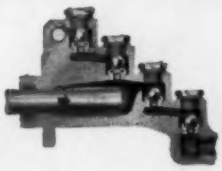
155 Compressors, Engines, Turbines — Bulletin 131, 28 pp, describes a line of compressors, engines, and turbines for petroleum, gas, processing, general industrial applications. Construction features are described and illustrated with cutaway views, and dimensional data and diagrams are included. Covers gas-engine-driven compressors, steam-engine-driven compressors, motor-driven compressors, diesel-engine-driven compressors, centrifugal pipeline compressors, radial inflow turbines, centrifugal compressors, combustion gas turbines, axial flow compressors, others. Includes photos of typical installations. Clark Bros. Co.

156 U-Tube Converters — Twelve-pp Bulletin 50 presents a line of converters applicable to heating and process systems using water under forced circulation at low and high temperature levels. Capacity



Standard Milton Roy Motor-Driven Controlled Volume Pump.

Exclusive Milton Roy
STEP-VALVE LIQUID END



Double ball checks, sloping passages and absence of air pockets assure highest possible volumetric efficiency. Should a solid particle lodge under one suction ball, for example, second suction ball will seat on discharge stroke, thereby preventing fluid from being pumped into suction piping.

Want to make your chemical metering more profitable?

Your operating and maintenance costs are lowest when you use Milton Roy Controlled Volume Pumps for metering process additives

Here are the features of Milton Roy Controlled Volume Pumps which contribute to their accuracy and dependability:

- Liquid ends can be constructed from a variety of materials for specific services.
- All parts are machined to close tolerances . . . base has web steel construction, provides rigidity required for perfect alignment.
- Cross-heads have large length-to-diameter ratio so that they fully support the plunger, increasing service life of packings.
- Rugged motors, gears, connecting rods and bearings easily withstand shock loads.

Accuracy of ± one percent increases end-product uniformity and reduces waste of metered chemicals. The result . . . lower production costs, more profitable operation.

Design and construction dependability provide long service life with minimum maintenance. The result . . . lower production costs, more profitable operation.

Milton Roy Controlled Volume Pumps serve equally well as flow controllers, ratio controllers, or final control elements . . . are available in simplex, duplex, and multiple liquid end types.

Whatever your chemical metering problem or requirement, a Milton Roy Controlled Volume Pump or Chemical Feed System will provide a trouble-free, economical solution. Capacities range from 3 milliliters per hour to 45 gpm . . . at pressures to 50,000 psi.

Write today for any of these bulletins:

"Controlled Volume Pumps in Process Instrumentation," Bulletin 1253.

"Controlled Volume Pumps in Industrial Water Treating," Bulletin 953.

"Controlled Volume Pumps in Paper Making," Bulletin 455.

Milton Roy Company
Manufacturing Engineers
1300 E. Mermaid Lane
Philadelphia 18, Pa.
Engineering Representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa

milton Roy
CHEMICAL FEED SYSTEMS

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TITUSVILLE Scotch Marine POWER BOILERS

The greatest customer-acceptance in Titusville's many years of Scotch Marine boiler manufacture requires shipments by the trainload to satisfy! The reason is an ever-wider appreciation of Titusville as a BETTER BOILER BUY. The developments and refinements found in our Scotch Marine boilers today are the fruit of longest experience and largest volume manufacture of this famous boiler type — steady progress that pays off in *value* to every user. Write for quotations on the capacity you require.

THE TITUSVILLE IRON WORKS CO.

BOILER DIVISION
BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

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A Division of Struthers Wells

TITUSVILLE, PENNSYLVANIA

Manufacturers of A Complete Line of Boilers for Every Heating and Power Requirement
Plants at Titusville, Pa. and Warren, Pa.
Offices in Principal Cities

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tables are arranged to allow easy determination of converter size, and a step-by-step method of selection is provided. Units described are company's Series K Paracoil U-tube steam-to-water converters. Those designed for radiant heating applications are listed. Davis Engineering Corp.

157 Dry Grinding Mills — Bulletin 17-C, 44 pp, contains descriptive and technical information on mills for dry grinding and pulverizing. Discussing the proper application and selection of conical mills, tricone mills, cascade mills, rod mills, tube mills and disc roll mills for dry grinding problems, it also describes various air classifying arrangements and shows a number of plant flow sheets. Mill auxiliaries, such as feeders and electronic controls, are also described. Complete specifications for a number of dry grinding mills are given, as well as detailed performance data for various materials. Hardinge Co., Inc.

. . . *Outstanding Among This Month's Catalogs*

158 Time Controls — This 20-pp information booket is designed as a complete reference to multi-purpose and industrial time controls. The booklet can be used as an up-to-the-minute check list of leading time switches and timers, and also provide correct answers for countless electrically operated automatic on-off operations. A fold-out reference chart defines each control, tells what it does, where it may be used and how to select and purchase it. Paragon Electric Co.

159 Power Transformer Data — Form 427-R-1, 80-pp, is a transformer instruction booklet which should be of value to those interested in power transformer maintenance and operation. Well-illustrated with photos, drawings and diagrams, booklet covers, in detail, such subjects as installation, operation, component parts, maintenance and inspection of power type transformers in all ratings. Included with the instruction book is an outline diagram, auxiliary wiring diagram and/or other pertinent information relative to the specific installation of a power transformer. Moloney Electric Co.

161 Gas Burning Equipment — Catalog 57, 33 pp, pictures and describes company's line of furnaces, burners, valves, torches, mixers, blowers, stock tank heaters and controls. Complete specifications and shipping weights are listed for each item. Photos, drawings, diagrams, typical installation diagrams and other illustrative detail are included, as well as a table listing capacities and orifice sizes for 2500 Btu propane gas. Johnson Gas Appliance Co.

162 Flash Lights, Safety Cans — Catalog 566, 16 pp, covers this company's flash lights, lanterns, safety lights, carbide lamps and safety cans. Provides a table of performance characteristics of bulb and battery combinations including the burning life of batteries and correct bulbs to use with various dry cells, depending on amount of light and battery life desired. Book is divided into sections, dealing with general purpose lamps and lanterns; special lights for industrial plants, utilities, others; safety lights for use in explosive areas; safety cans for handling oily wastes and flammable liquids. Justrite Mfg. Co.

Your J-M Packings Distributor can tell you why this quality sheet packing has maintained such an excellent reputation for over 35 years

Where it's used: Every industrial plant can use J-M Service Sheet Packing to advantage. It's the favorite packing of thousands of plant engineers and maintenance men. Both versatile and dependable, Service Sheet makes a tight, long-lasting seal against superheated steam, air, gas, water, hot oil and ammonia, as well as many acids and chemicals.

What its advantages are: J-M Service Sheet is a quality packing, made of selected long-fibre asbestos bonded with heat-resisting compounds. It is graphited on one side to permit breaking a joint without destroying the gasket. The ungraphited side is ruled into one-inch squares to speed cutting and reduce waste. And . . . you can order it in large economical quantities because J-M Service Sheet will not dry out in stock!

How it is furnished: Service Sheet is supplied in sheets 54″ x 63″, 36″ x 126″, 36″ x 63″, and 54″ x 126″ sheets in thicknesses of 1/64″ to ¼″ and 108″ x 126″ sheets in thicknesses of 1/32″ to ¼″. It is also furnished as cut gaskets in standard and special shapes. See the J-M catalog for further details.

Your J-M Packings Distributor carries complete stocks of J-M Service Sheet and other quality Johns-Manville Packings. He can help you choose the right packing for your application. Write him for complete information and copy of folder PK-19A, "Thousands of Plants Rate It Tops." Or address Johns-Manville, Box 14, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville PACKINGS & GASKETS

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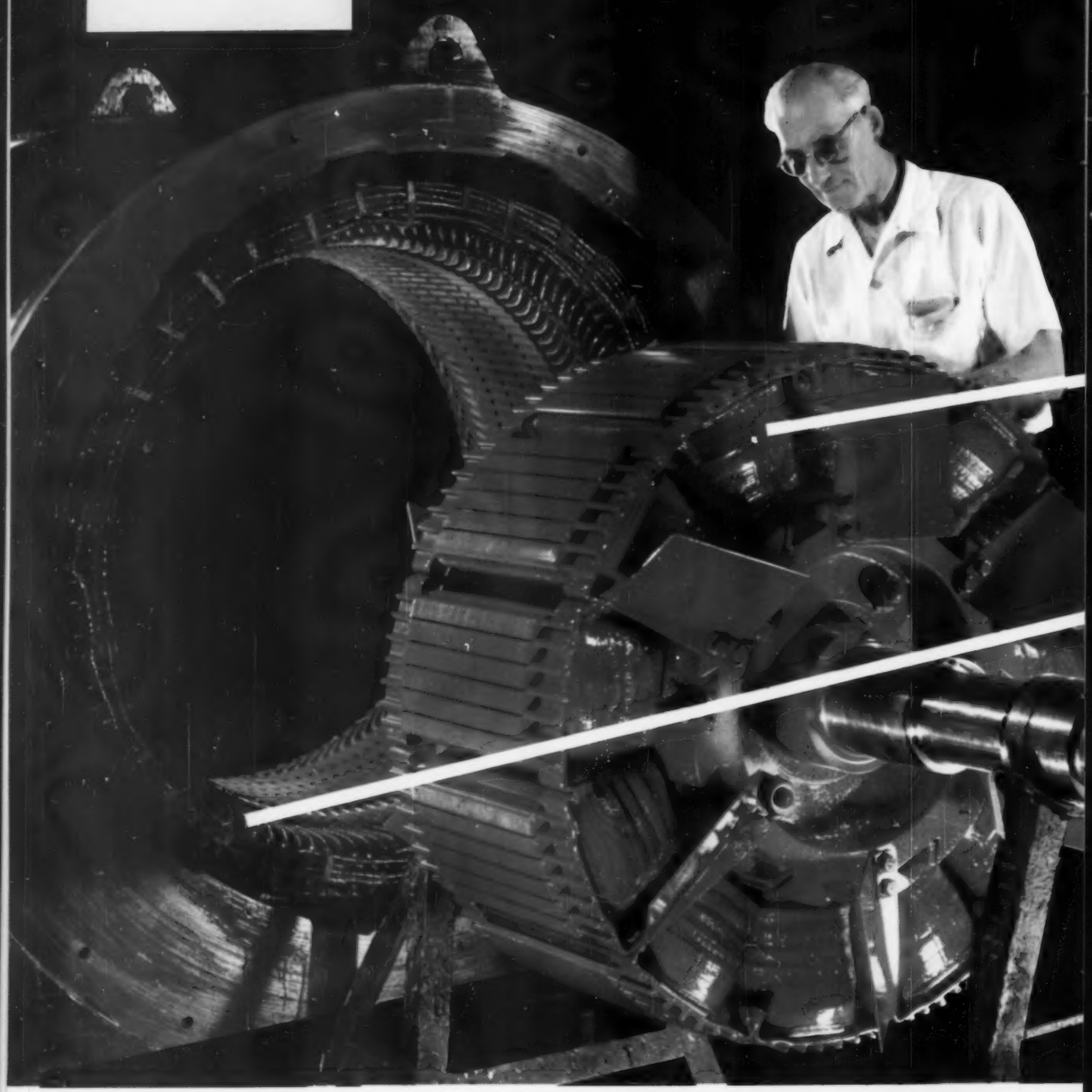
ONLY Allis-Chalmers



ALLIS-

MOTORS are "double protected"

New Integrated Field Coils Plus *Silco-Flex* Stator Insulation Provide Superior Motor Protection... Under Any Operating Conditions

1

Integrated Field Coils are bonded in heat-stabilized resins, enclosed in a resin-impregnated sheath of oriented glass fibers and bond-locked on the pole structure . . . dimensionally stable to withstand heating and thermal shock, vibration and fatigue at elevated temperatures . . . sealed throughout against atmospheric contaminants and fully protected against destructive forces.

2

***Silco-Flex* Insulation** provides a homogeneous, void-free insulating wall of silicone rubber on stator coils. It is unexcelled in life and thermal stability at high temperatures . . . resistant to most chemicals, water, weather . . . outstanding in flexibility and resilience . . . able to withstand abrasion and corona . . . resistant to physical and mechanical forces.

Exclusive Allis-Chalmers "double protection" is available on large electrical machines with operating temperatures through Class B range.

Silco-Flex is an Allis-Chalmers trademark.

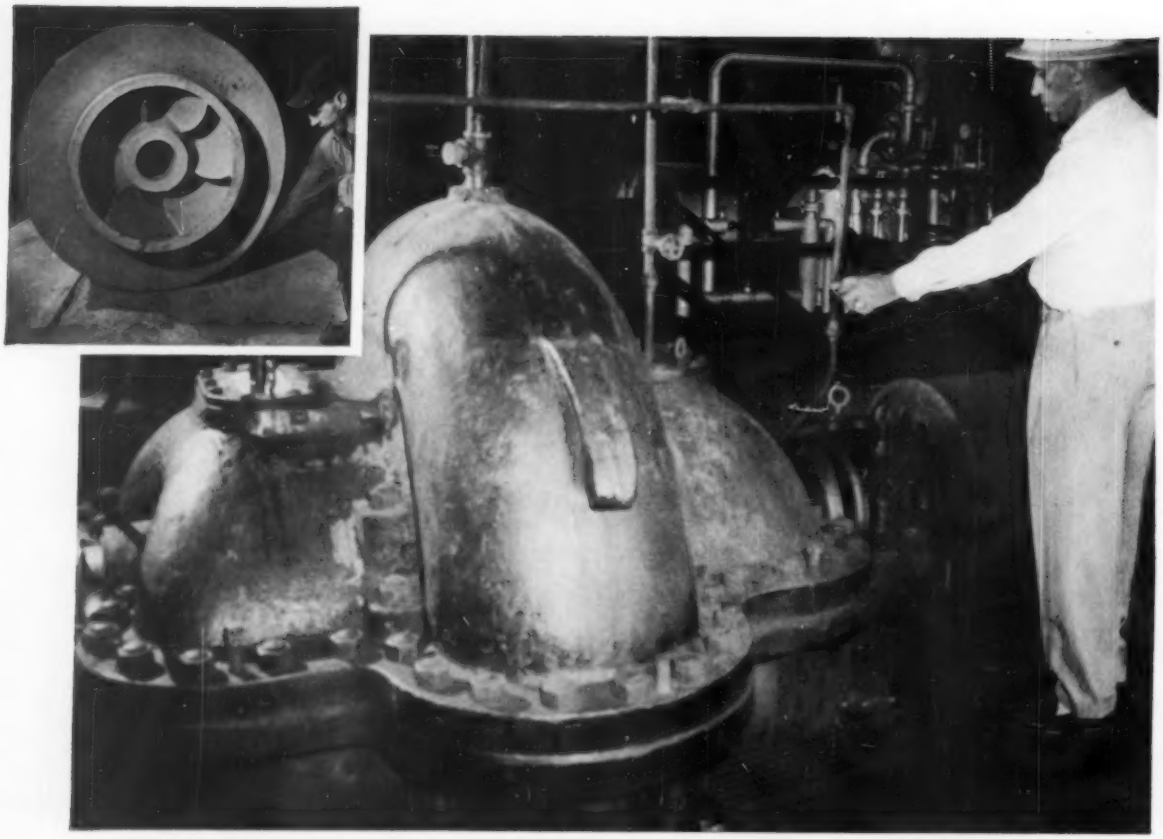
For more information on these quality insulation systems contact your nearby A-C office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin for Integrated Field Coil Bulletin 05R8525 and *Silco-Flex* Insulation Bulletin 05R8341.

Allis-Chalmers "Double Protection" with integrated field coils and Silco-Flex stator coil insulation, adapts this 600-hp, 2300-volt, 600-rpm synchronous motor to the most severe operating conditions.

CHALMERS

A-C ALLIS-CHALMERS

A-5221



No Slow Joe. This power plant pump handles 240,000 gallons of salt water every hour. Its 2,200-pound impeller — cast by the INCO Foundry at Bayonne, N. J. — is shown at upper left. To meet Caloil demands for *utmost* corrosion resistance, it's made of *Monel!*

Pumping salt water at 40,000 gpm

Monel impeller helps coastal power plant end threat of breakdown by corrosion

The California Oil Company has a big industrial power plant at Perth Amboy, New Jersey. Right at hand is all the water they need for their cooling system.

But it's *salt* water. And you know how destructive that can be . . . what corrosion it can cause.

So Caloil had an impeller of Monel* nickel-copper alloy put in. Weighing 2,200 pounds, it was specially cast at INCO's Foundry in Bayonne, New Jersey.

This large Monel casting has excellent resistance to corrosion. And it's *tough*, too! Actually, Monel lends more strength than the impeller *needs* to stand centrifugal stresses and plenty of hardness to resist wear.

Over and over, that's the way it is with Monel. It gives you an *extra* margin of performance. Helps make your equipment last longer. Helps keep your maintenance expense low. And helps make downtime less of a threat!

There are probably *many* ways Monel can save money for you. Find out more about them. Ask for "Engineering Properties of Cast Monel" and "Cast 'S' Monel." Write today!

*Registered Trademark

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

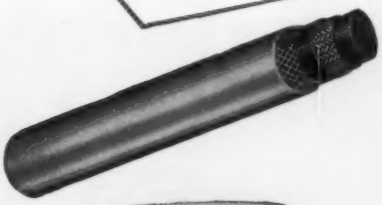
More POWER for you . . . with MONEL

INCO NICKEL ALLOYS

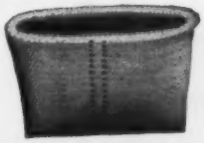
TRADE MARK

For more data circle 524 on Post Card

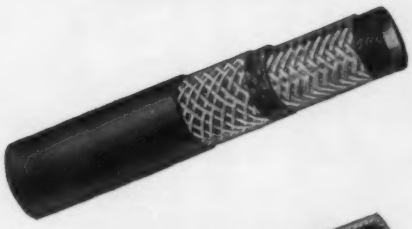
For long, trouble-free service . . . use Quaker hose



AIR Extra lightweight, highly flexible hose for heavy duty work. Resists weather damage and abrasion. Non-porous tube of oil resistant rubber compound. Rugged Neoprene cover. Ideal for almost any hose installation.



FIRE Resilient, flat-folding hose saves space and gives long service in interior fire protection. Highly flexible and resistant to cracking. Leak-proof tube bonded to strong single jacket cover. Recommended for institutions, offices, ships, etc.



STEAM Many times stronger than wrapped fabric hose for general steam-handling jobs. Also lighter, more flexible and kinkproof for easier handling. Steel wire and glass reinforcing insures extra safety. Resists high pressures up to 388° F.

WELDING No twisted, tangled lines. Two lines are securely bonded together to form a single, safe hose unit. Kink-free and resistant to welding gases. Stands up to lots of dragging across rough surfaces. Especially effective on portable welding dollies.

WATER For long wear and outstanding value, this easy-to-handle hose has what you need. Reinforced with multiple plies of high tensile yarn, it takes higher than usual working pressures. Cover stands up to weather extremes without cracking or peeling.

Save time and money. Call your Quaker-Quaker Pioneer distributor first, when you need hose or other industrial rubber products. You'll find him prompt, dependable.

H. K. PORTER COMPANY, INC.

HKP

QUAKER RUBBER DIVISION
Philadelphia 24, Pa.

QUAKER PIONEER RUBBER DIVISION
Pittsburg, Calif.

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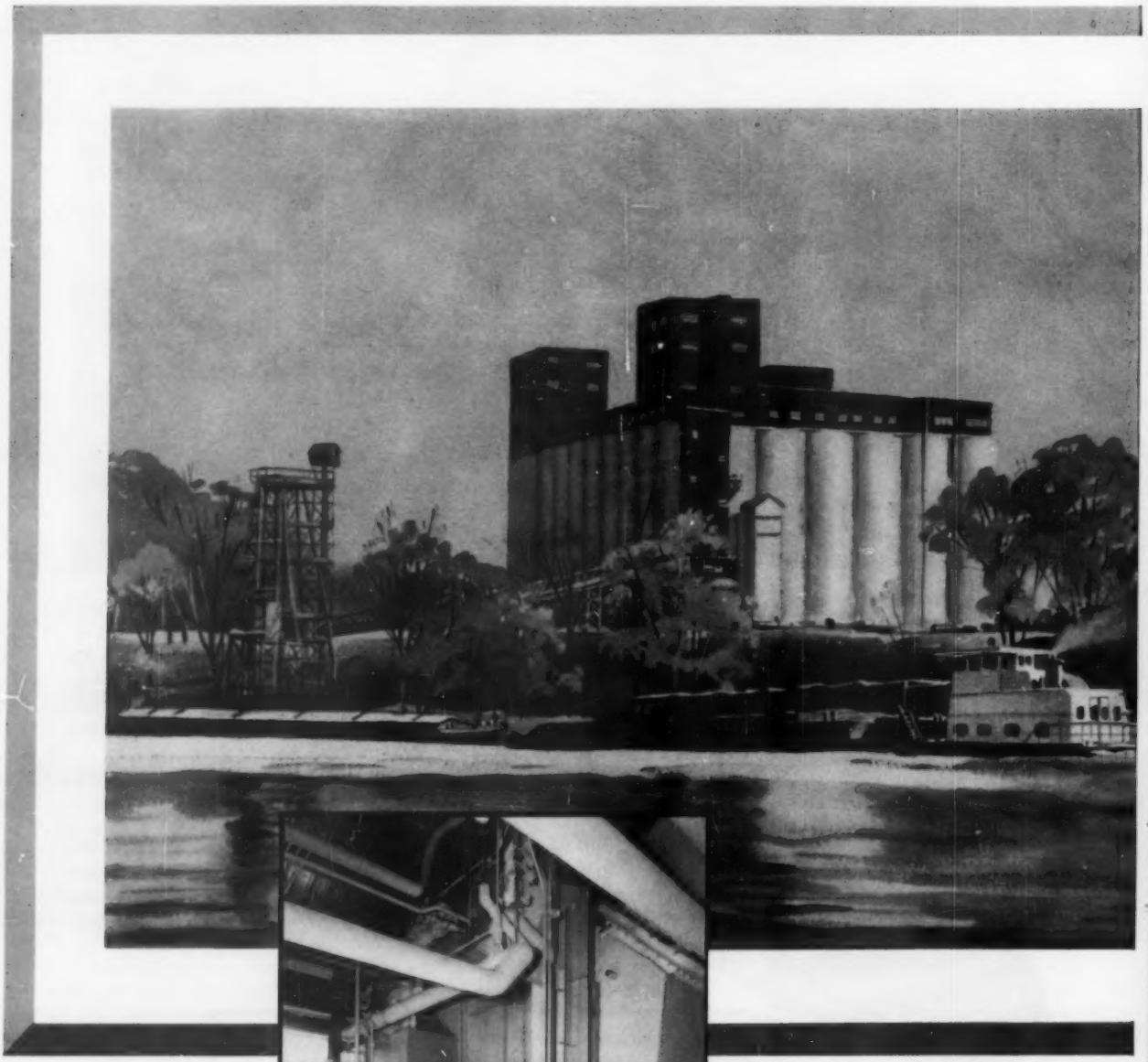
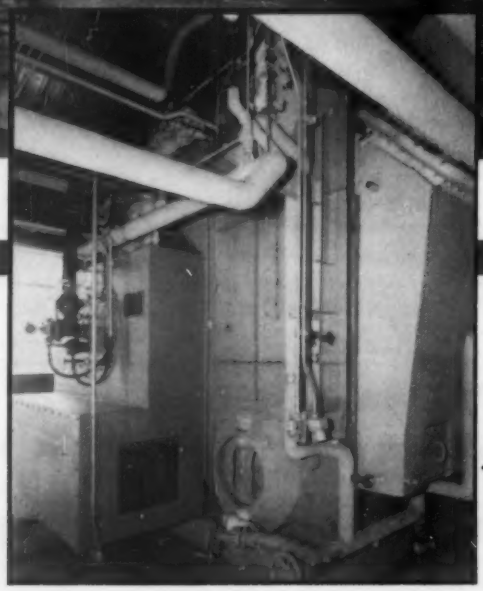
"RELIABLE–ECONOMICAL





▲ From an original water color of the Central Soya Co., Inc.—McMillen Feed Mills—by Kent Day Coes. Commissioned by "Factory" magazine for their 1956 Significant Plant Awards.

◀ C-E Package Boiler, Type VP which supplies all steam requirements. Capacity 40,000 lb of steam per hr, operating pressure — 155 psi. Gas fired.

–LOW ON MAINTENANCE"

Says Mr. Max R. Spencer – Superintendent Central Soya Co., Inc. – McMillen Feed Mills

"Our package boiler, after 18 months of operation, has proven to be very reliable, economical and low on maintenance costs. Ease of start-up, shut-down and continuous operation permitted quick training for our operators."

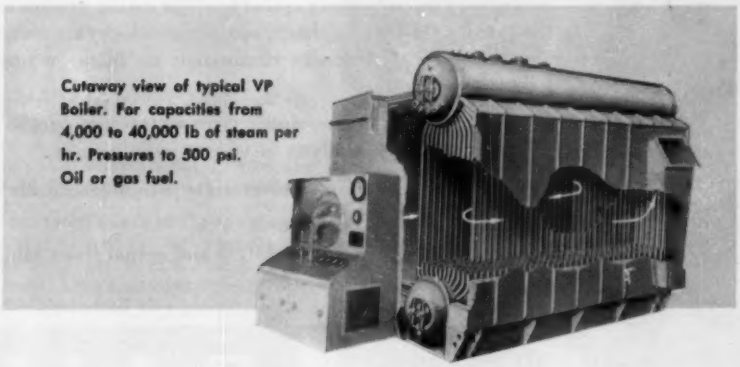
Mr. Max R. Spencer, Maintenance Superintendent of the Central Soya Co., Inc. – McMillen Feed Mills – of Chattanooga, Tenn., was referring to his C-E Package Boiler, Type VP, when he made that statement.

It's a boiler that has to be good – has to be reliable – for it is presently the sole source of steam supply for this outstanding plant. And it *is* an outstanding plant having been named one of "The 1956 Winners of Factory's Significant Plant Awards".

Central Soya is a real, modern "triple threat" operation. It comprises: (1) mammoth new grain-handling elevators, (2) feed mill, and (3) soybean solvent extraction plant all integrated into a smoothly operating "continuous process" plant that is expandable and ready for any foreseeable need.

Combustion Engineering is proud that its VP Package Boiler has been assigned a key role in the operating plan of this notable mill. Gratified, too, that it is proving to be all that Mr. Spencer had hoped for.

A C-E Package Boiler, Type VP can do the same kind of a job for you. Let us give you more information.



Cutaway view of typical VP Boiler. For capacities from 4,000 to 40,000 lb of steam per hr. Pressures to 500 psi. Oil or gas fuel.

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

B-962

CANADA: COMBUSTION ENGINEERING—SUPERHEATER LTD.

STEAM GENERATING UNITS • NUCLEAR REACTORS • PAPER MILL EQUIPMENT • PULVERIZERS • FLASH DRYING SYSTEMS • PRESSURE VESSELS • HOME HEATING AND COOLING UNITS • DOMESTIC WATER HEATERS • SOIL PIPE

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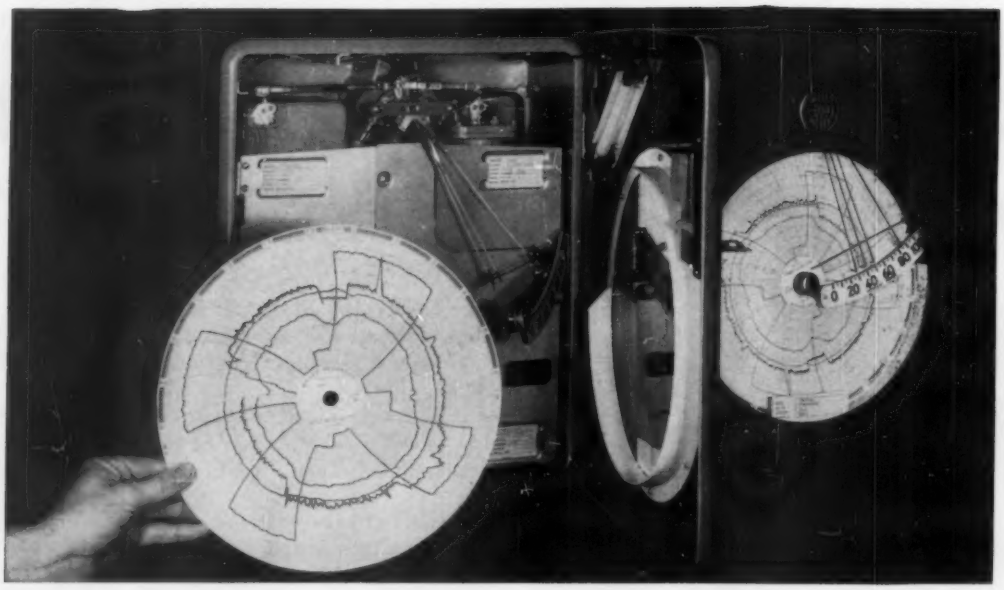

Faithfully yours –

Clear, Continuous Records without Poisoning . . . on the New Bailey Recorder

★ Faithful chart records of measured variables are the key to a meaningful, dependable analysis of operating trends and conditions. Money spent for more accurate metering, for faster response, is money down the drain—*unless* it's matched with chart records that are equally accurate.

That's why these features of the new Bailey Recorder are important to you:

1. Bailey's exclusive sealed capillary-action inking system maintains continuous flow to the pen tip, and traces sharp, opaque, quick-drying records. "Poisoning" of intersecting records is practically eliminated; no blots or smears during operation or chart changing.

2. Pens are mounted on concentric centers, trace on parallel time arcs only 42/1000" apart. This simplifies analysis of two or more records.

3. Interchangeable plug-in receiver units permit practically limitless record-grouping combinations.

Write for Product Specification E12-5 and actual chart sample. PRS-1

ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER

- Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
- A full year's ink supply at one loading
- Faster shipment—from stock
- Minimum inventory of parts
- Minimum instrument investment for process cycle expansion or alteration

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1040 IVANHOE ROAD
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Controls for Power and Process

BAILEY METER
Controls for
TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW · LEVEL
RATIO · DENSITY

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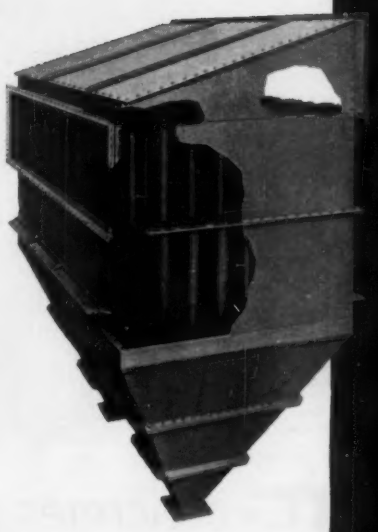
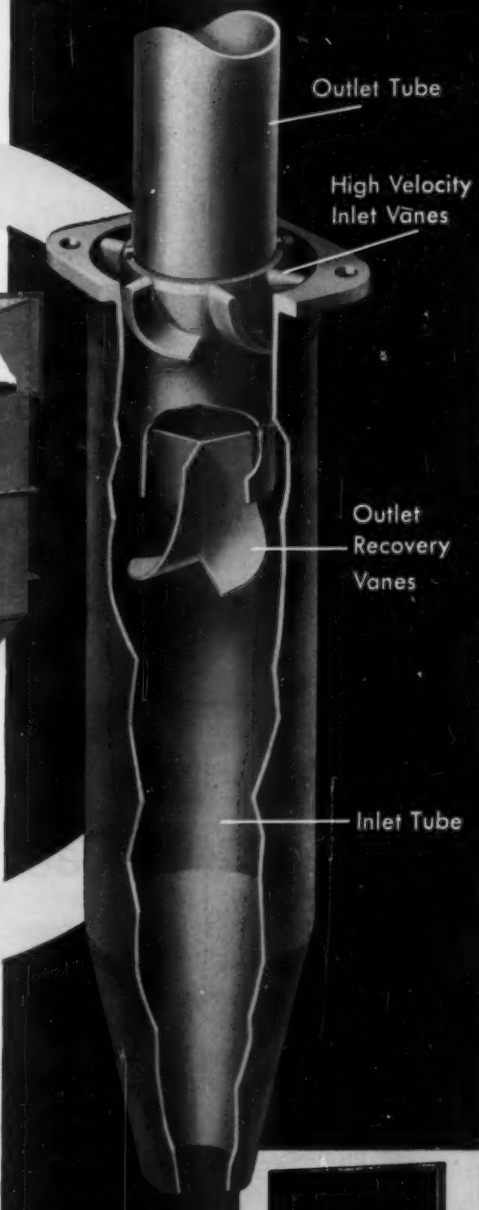
NEW Cyclo-trell

multiple tube dust collector





Here are a few brief facts on Research's new multiple tube mechanical collector.

- Collection efficiencies are higher, for a given pressure drop, than other conventional multiple tube collectors.
- Gas flow per tube is higher than conventional units. This means fewer tubes per collector and lower total cost for a given capacity.
- Cyclo-trell's design is based on Research's 45 years experience in manufacturing gas cleaning equipment. As the largest manufacturer of electrical precipitators in the world, Research-Cottrell has engineered and built many combination units consisting of precipitators and mechanical collectors.

Higher Collection Efficiency

An important reason for Cyclo-trell's higher collection efficiency is the aerodynamically shaped inlet vane unit. The purpose of these vanes is to produce a fast spiral of incoming gas. The faster these gases spin, the greater the centrifugal force on the suspended dust.

After testing many types and curvatures of vanes, Research found that this new design resulted in less turbulence, greater centrifugal force and higher collection efficiencies.

Greater Gas Handling Capacity

To develop a higher gas flow capacity than other multiple tube collectors, Research's engineers developed the following design features. First, by using a 10" diameter inlet tube, instead of the conventional 9" tube, the flow of incoming gas was increased.

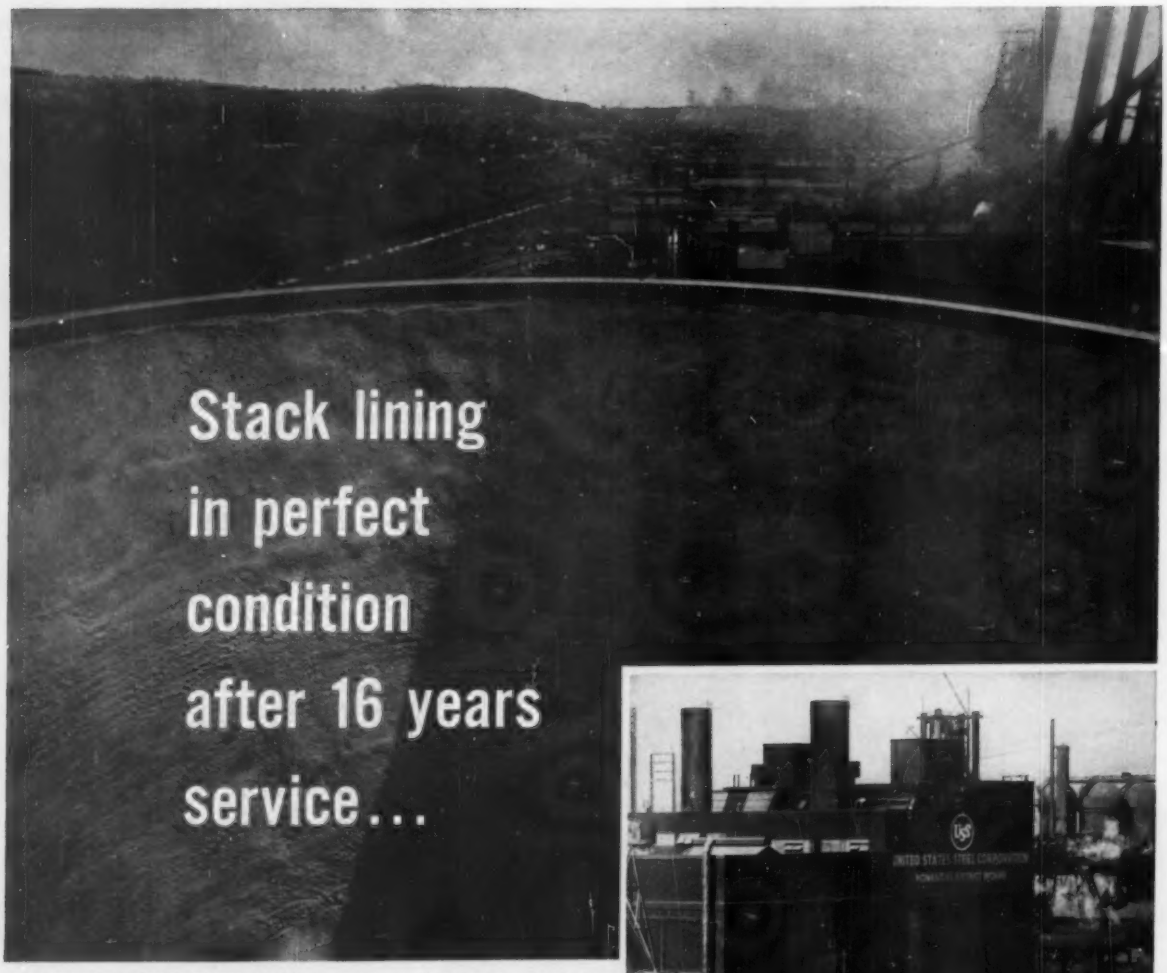
The next step was to straighten the gas flow as it entered the outlet tube, since a spiraling gas stream creates more resistance than a straight through flow. In the Cyclo-trell this spiral is eliminated, and energy is recovered, in the outlet tube by the Outlet Recovery Vanes. By positioning these vanes below the tube, rather than inside, resistance has been further reduced.

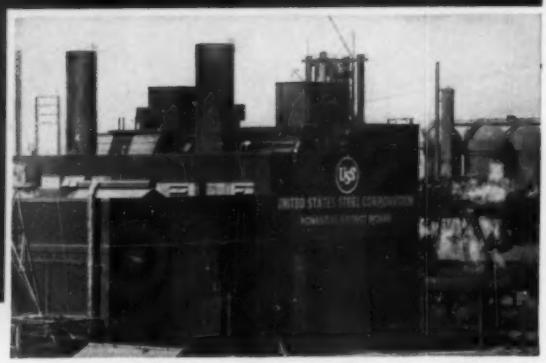
This combination of features means greater gas flow per tube, fewer tubes per collector and a lower total cost for a given capacity and efficiency.

Bulletin M gives complete details on design features, efficiency, capacity and detailed dimensional drawings. Write for your copy today.

Research-Cottrell, Inc.

Main Office and Plant: Bound Brook, N. J. • 405 Lexington Ave., New York 17, N. Y. • Grant Bldg., Pittsburgh 19, Pa. • 228 N. La Salle St., Chicago 1, Ill. • 111 Sutter Bldg., San Francisco 4, Cal.





DEPENDABLE PERFORMANCE of Lumnite lining is illustrated by excellent service condition of No. 3 Boiler House Stack, Carrie Furnaces Plant, Homestead Works, U. S. Steel Corp., Munhall, Pa.

because **LUMNITE***-concretes provide resistance to heat, corrosion and abrasion

To be sure of trouble-free performance in *your* steel stacks, line them with long-lasting Lumnite linings. Quickly "shot" in place, these smooth, jointless linings improve drafts . . . protect stacks and breechings from attack of corrosive gases . . . and the abrasive action of high-velocity fly ash.

In fact, wherever heat, corrosion and abrasion are problems, use concrete made with Lumnite calcium-aluminate cement. Keep a supply of Lumnite cement or prepared Lumnite-base castables on hand for emergency needs. Packaged castables are made and distributed by leading manufacturers of refractories. All you do is add water, mix and place. For more information, write:

UNIVERSAL ATLAS CEMENT COMPANY

UNITED STATES STEEL CORPORATION SUBSIDIARY

100 PARK AVENUE, NEW YORK 17, N. Y.

*"LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company

L-136

Atlas® Lumnite Cement

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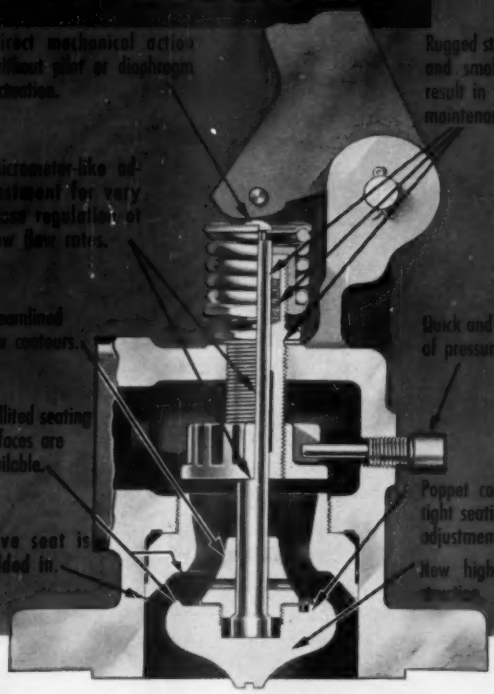
POPPET TYPE VALVES

An IMPORTANT REASON for the better performance of *these*


Direct mechanical action without pilot or diaphragm actuation.
Micrometer-like adjustment for very close regulation at low flow rates.
Streamlined flow contours.
Stellited seating surfaces are available.
Valve seat is welded in.
Rugged stem, proper guiding and small packing surface result in minimum maintenance.
Quick and simple adjustment of pressure control.
Poppet construction assures tight seating without critical adjustment.
New high-flow valve construction.

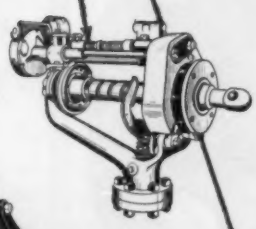
DIAMOND Blowers

Note carefully the important advantages pointed out on the illustration above. You will see why Diamond Poppet Type has proved its superiority by many years of successful operation on the most difficult jobs.

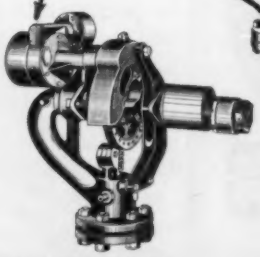
The integral adjustable pressure control device is used when boiler or header pressure is higher than desirable for blowing. Its location outside the path of valve travel permits full and immediate opening of the poppet valve, thus avoiding wire drawing.

The valve readily lends itself to examination and repair. Disc and seat are quickly accessible, and regrinding can be done quickly without dismounting the head. Seat and disc are forged and the stem rolled from stainless steel.

This valve construction is one of the many reasons why Diamond Blowers give better boiler cleaning at lower cost.



Diamond Model IR
Retracting Blower
See Bulletin 1079



Diamond Model G9B
Automatic Valve Blower
See Bulletin 1137A

Diamond Model IK
Long Retracting Blower
See Bulletin 1080A

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO
Diamond Specialty Limited, Windsor, Ontario

7530

For more data circle 530 on Post Card

NO Reducing Valve Needed

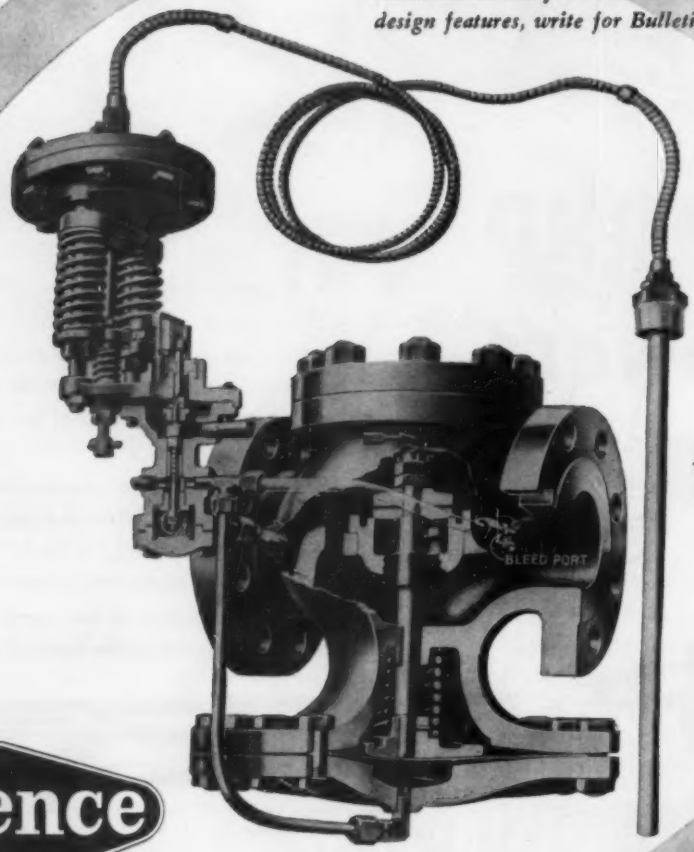
Here's real economy in temperature control.

Because Spence Temperature Regulators are designed to limit heater steam pressures to an adjustable maximum, the need for a separate reducing valve is completely eliminated.

The Spence Regulator takes steam directly from the boiler or high pressure line, reduces the pressure and regulates the flow as required to maintain a constant temperature output from the heater.

This means one relatively small combination pressure and temperature regulator replaces a reducing valve of the same size and a larger temperature regulator. Practically the entire cost of the large separate temperature regulator is saved. And, the total saving would also include the cost of a 3-valve by-pass along with all labor for installation.

This design feature is just one of the reasons for the thousands of Spence installations throughout American industry. *For details of other important design features, write for Bulletin T50.*



SPENCE
TYPE ET150
Temperature
Regulator

Spence

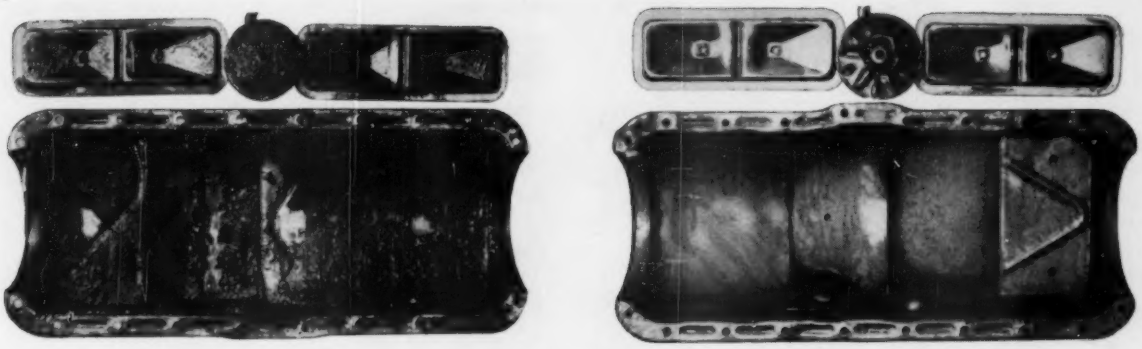
SPENCE ENGINEERING COMPANY, INC.
WALDEN, NEW YORK

SE-139

For more data circle 531 on Post Card

PROOF POSITIVE...

of SINCLAIR Diesel Oil Superiority!



This is actual photographic proof of the superiority of Sinclair Diesel Lubricants. On the left is a truck engine sump in which an ordinary oil was used. The clean sump on the right reflects conditions when a Sinclair Diesel Oil, SUPER TENOL, was used. This same top quality lubrication performance can be expected from all Sinclair Diesel Oils . . . *because Sinclair has the exact oil to match your engine's requirements!*

Sinclair RUBILENE® – These high viscosity index oils, refined by Sinclair's famed Phetone Process, have a long history of outstanding performance and are extensively used in stationary Diesel power plants today.

Sinclair RUBILENE HD – These high viscosity index oils contain additives which provide excellent detergent – dispersant properties, oxidation resistance, bearing corrosion prevention and anti-foam qualities. They are especially suitable for stationary Diesels as well as the higher speed Diesels used in industrial plants.

Sinclair GASCON® – These naturally detergent, straight mineral oils are recommended for slow, medium and high speed Diesels where carbon deposits, engine cleanliness and easy, low temperature starting is important.

Sinclair GASCON HD – Heavy duty detergent type oils compounded with selected additives to provide extra detergent dispersant properties, bearing corrosion prevention, oxidation resistance and anti-foam characteristics.

Sinclair TENOL®, SUPER TENOL and TENOL EXTRA – A series of heavy duty, detergent–dispersant type, high viscosity index oils refined by the Sinclair Phetone Process. Recommended for all high speed automotive fleet Diesel engines, and for some engines of late design in stationary, portable and marine service. All three series contain varying degrees of additive concentrations necessary to give outstanding performance no matter what the service condition under which your Diesel operates.

For further information about Sinclair's trouble-proof Diesel lubricants, see your Sinclair Representative, or write Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. *There's no obligation.*

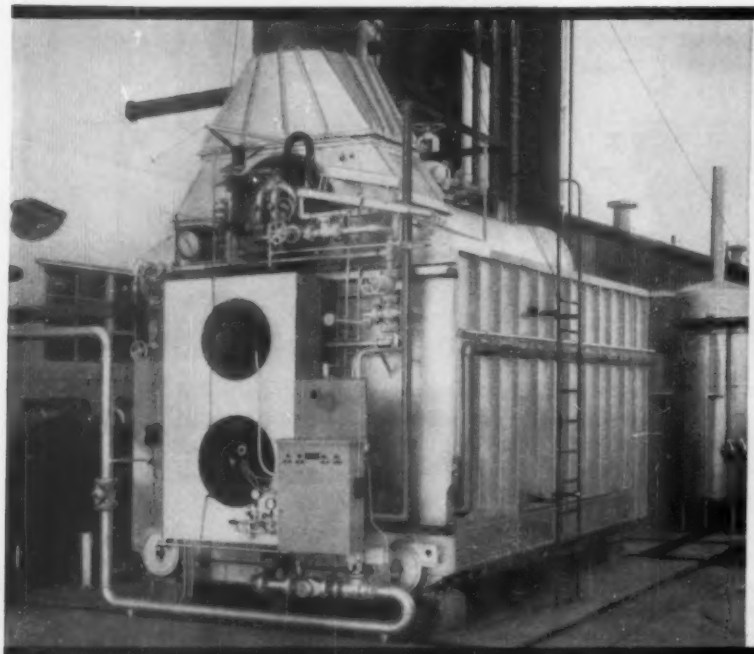
SINCLAIR

DIESEL OILS

For more data circle 532 on Post Card

UNION PACKAGED BOILERS

give Tri-Valley the steam it needs to pack 3,200,000 cases of canned food



30,000 lbs. of steam per hour — that's the capacity of this Union Type MH Steam Generator serving Tri-Valley's San Jose cannery. It's part of a complete boiler plant designed and constructed by Union's West Coast affiliate, Union Iron Works of California, Inc.

PEAR-LADEN CONVEYORS keep production on the move inside Tri-Valley's San Jose plant.

BIRD'S EYE VIEW of Tri-Valley's Modesto plant which utilizes a 30,000 lb./hr. Union Packaged Boiler for process steam.

Producing 24 varieties of canned foods, Tri-Valley Packing Association is one of California's largest independent canners. In 1955, it packed 58,000 tons of raw fruits and vegetables... *3,200,000 cases!*

Providing steam for the canning process as well as for operating cannery process equipment in each of Tri-Valley's two recently-modernized plants is a 30,000 lb./hr. Union Type MH Packaged Steam Generator.

In 1953, Tri-Valley's first MH Unit went to work in the Modesto plant. When the Association's San Jose plant needed a new boiler in 1955, another Union MH Packaged Boiler was picked for the job. Says Tri-Valley, "Our selection was based upon our evaluation of the design... and the performance of the Union MH Packaged Boiler installed in our Modesto plant."

The efficiency of the new Union Generator at the San Jose plant has been checked at 77.88% on gas firing at 33,000 lbs./hr., which is 10% over rated maximum continuous output.

From coast to coast, Union Packaged Steam Generators are stacking up impressive job records in chemical processing plants, pulp and paper mills, breweries, refineries, institutions, schools and hospitals, to name but a few.

Completely shop-assembled at Union Iron Works for delivery via rail or truck, Type MH Units can be equipped to handle multitudes of needs formerly requiring costly field erection and special engineering. Standard units are designed in 13 sizes from 10,000 to 50,000 lbs. of steam per hour.

GET THE FULL STORY including cut-away illustrations, tube layouts and dimension tables by writing for Bulletin MH-353.

UNION

UNION IRON WORKS

ERIE, PENNSYLVANIA

For more data circle 533 on Post Card

R.T.M.
This steel valve with these standard features has an original cost in the bronze valve bracket. S.P.D.

ROCKWELL BUILT
Edward Valves

Centerless ground EValloy stem increases packing life; cuts maintenance.

"Y" design reduces pressure drop turbulance wear.

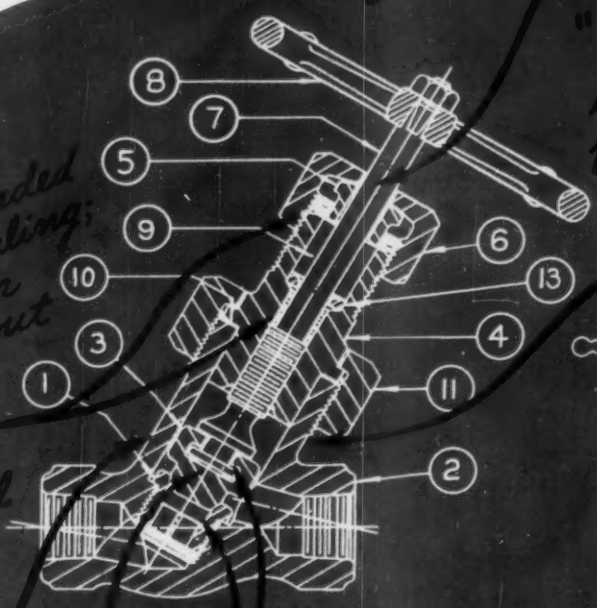
EValized threaded surfaces stop fouling; make operation easy throughout valve service life.

All forged steel construction reduces bulk eliminates porosity.

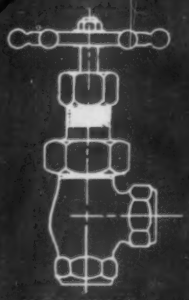
Solid EValloy stainless stem, seat and disk add years of service to this steel valve.

Vacuum test on mated seat and disk insure drop-tight closures.

We can save money and cut replacement cost with Edward Fig 2698 globe and 2699 angle valves. Let's order them.



GLOBE VALVES-SCREWED ENDS FIG. 2698



ANGLE VALVES
SCREWED ENDS—FIG. 2699
SOCKET WELDING ENDS—FIG. 2699Y
EXCEPT FOR BODIES GLOBE & ANGLE VALVES ARE ALIKE

LIST OF MATERIAL
QUANTITIES ARE FOR 1 GLOBE OR ANGLE VALVE

PIECE Nº	NAME OF PIECE	Nº REQ'D	MATERIAL	SPECIFICATIONS	STANDARD MTLS Nº
1	SEAT	1	EVALLOY	A.S.T.M. A182, F6	212
2	BODY	1	FORGED STEEL	A.S.T.M. A105, CLASS II MAX C 0.30%	111
3	DISK	1	EVALLOY	A.S.T.M. A182, F6	212
4	BONNET	1	FORGED STEEL-EVALIZED	A.S.T.M. A105 CLASS II	111
5	GLAND	1	STEEL		123
6	PACKING NUT	1	STEEL-EVALIZED		
7	STEM	1	EVALLOY	ASTM. A182, F6	212
8	HANDWHEEL	1	MALLEABLE IRON	A.S.T.M. A47, GRADE 32510	322
9	PACKING		EVALPAK		501
10	GASKET	1	ARMCOTE (NO ASBESTOS)	ARMCO IRON	505
11	UNION RING	1	STEEL	A.S.T.M. A105 CLASS II	111
13	JUNK RING	1	S.A.E. STEEL	EVALIZED	
14	Nº 1 BABBIT CHAIN	1			
15	PADLOCK	1	BRASS		

EDWARD VALVES, INC.
SUBSIDIARY OF ROCKWELL MANUFACTURING CO.
EAST CHICAGO, INDIANA

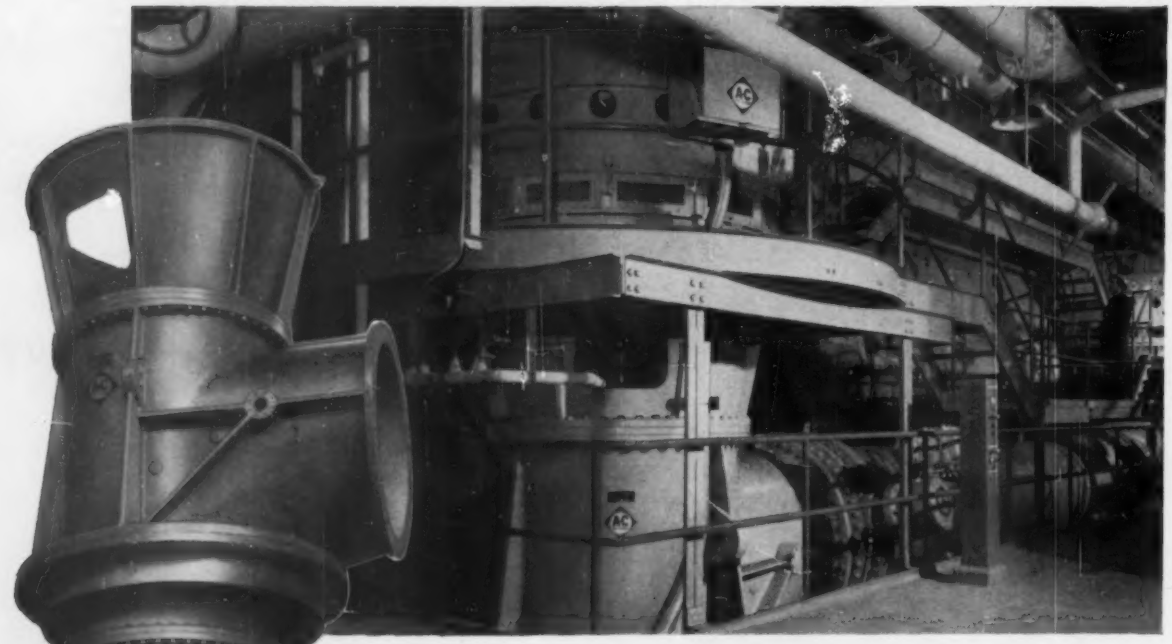
FORGED STEEL 600 LB
GLOBE AND ANGLE VALVES
GENERAL ASSEMBLY

DRAWN
CHK'D
APP'D
DATE: 6-19-52

BE-3034-3

Edward builds Globe and Angle Stop, Non-Return, Check, Stop-Check, Gate, Blow-Off, Mudline, Relief, Hydraulic, Instrument, Gage, and Special Valves and Strainers.

Allis-Chalmers Pumps Meet Power Plant Requirements



Continuous Condenser Service at Detroit Edison's River Rouge Plant

At River Rouge Station, these Allis-Chalmers 84 by 60-inch circulating pumps, driven by 500-hp motors, deliver 73,000 gpm to the A-C condenser.

They play an important part in assuring service continuity at this station. An accurately cast impeller, hand finished and dynamically balanced, assures smooth operation. Other features, including a rigid whip-free shaft, and tube-protected shaft and rubber bearings lubricated with filtered water, have made A-C circulating pumps popular throughout the power industry.

Many customers use Allis-Chalmers test facilities to properly design their intake structures.

You Get **MORE** than a Pump . . . When You Specify Allis-Chalmers

You can take advantage of Allis-Chalmers wide experience in supplying pumps to all industries. You are assured of modern design, heavy-duty construction and correct application aid — all adding up to many years of dependable service.

Allis-Chalmers is the only company that can offer you "One-Source" responsibility, with a complete unit — pump, motor and control — all built to work together. For "MORE" information about Allis-Chalmers pumps, call your local A-C office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin. A-5216

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

For more data circle 535 on Post Card

Greenlee cuts steam costs 18%-20% burning coal the modern way

Consult an engineering firm

Designing and building hundreds of heating and power installations a year, qualified engineering firms can bring you the latest knowledge of fuel costs and equipment. If you are planning the construction of new heating or power facilities—or the remodeling of an existing installation—one of these concerns will work closely with your own engineering department to effect substantial savings not only in efficiency but in fuel economy over the years.

facts you should know about coal

In most industrial areas, bituminous coal is the lowest-cost fuel available • Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar • Automatic coal and ash handling systems can cut your labor cost to a minimum. Coal is the safest fuel to store and use • No smoke or dust problems when coal is burned with modern equipment • Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

Expanding facilities at Greenlee Bros. & Company, Rockford, Illinois, created a problem common to many growing firms. The Company's three old boilers had to operate continually at maximum capacity, so that a forced outage could hurt plant production. In addition, peak load operation with outmoded equipment resulted in high fuel costs.

While the newest boiler was retained, Greenlee replaced the other two with modern high-capacity units, including stokers, up-to-date controls and other equipment for more efficient operation. A new, pneumatic ash handling system was installed. Today Greenlee is getting 10%-20% more steam for each pound of coal burned and steam costs are down 18%-20%, saving Greenlee thousands of dollars every year.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

BITUMINOUS COAL INSTITUTE

Southern Building • Washington 5, D. C.

For more data circle 536 on Post Card

Cleveland Electric generates more power, more efficiently

Worthington heat and fluid transfer equipment helps Eastlake Station attain efficiency of ¾ lb of coal/kwhr

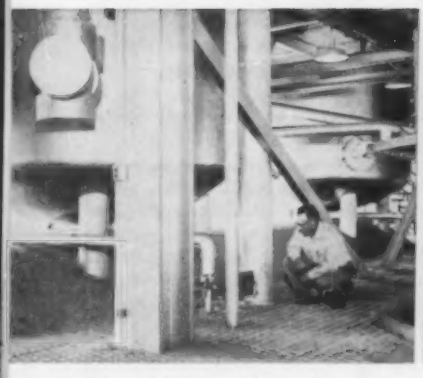
To a large extent good heat rate in any power plant is determined in three important places . . . in the boiler room where steam is produced, in the turbine room where electricity is generated, and in the heat and fluid transfer section of the plant where the condenser, its auxiliaries, and the boiler feed pumps play an important part in controlling plant heat balance. It's a fact that efficiency depends as much on all this latter equipment as on the rest of the plant.

That's why in designing their new 660,000 kw Eastlake plant, Cleveland Electric Illuminating engineers spent hundreds of hours studying various system arrangements. For all four generating units the condensers, deaerators, boiler feed pumps, vacuum pumps, and other miscellaneous auxiliaries were supplied by Worthington who offered coordinated design, engineering and manufacturing on these products. This careful study contributed greatly to the achievement of one of the most efficient and modern steam power plants in operation today.

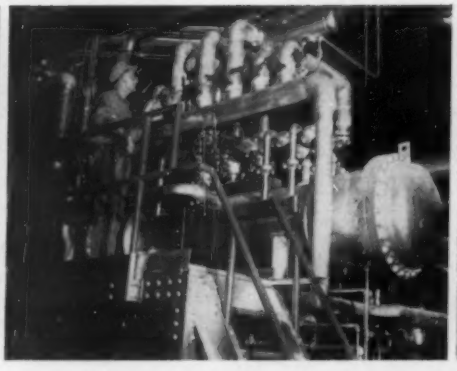
This "system wise" experience has been responsible for many Worthington steam power equipment advances such as high speed boiler feed pumps running up to 9,000 rpm; full contact deaerators which need practically no maintenance because they do away with the vent condenser; and "Double Folded Tube Layer" condensers which can be "tailored" to available space.

We'd like to put this experience to work for you. Just get in touch with us at your nearest Worthington District Office. Or write to Worthington Corporation, Steam Power Dept., Harrison, New Jersey. In Canada: Worthington (Canada) 1955, Ltd., Toronto, Ontario. S64

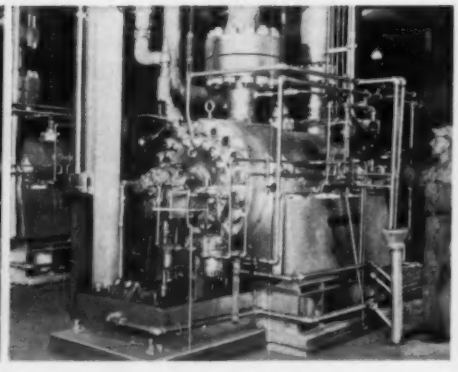
WORTHINGTON



Deaerators. This 1,515,000 lb./hr. unit at Eastlake consists of two vertical shells mounted on horizontal storage tank.

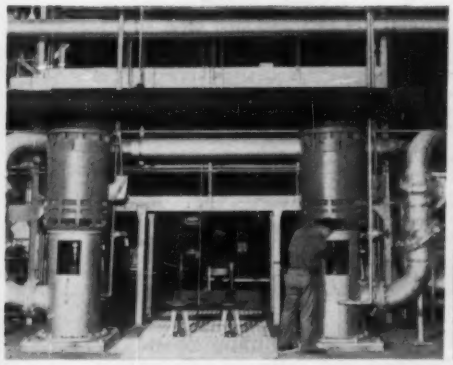


Ejectors and Vacuum Pumps. One of four steam-jet air ejectors serving condensers at Eastlake.

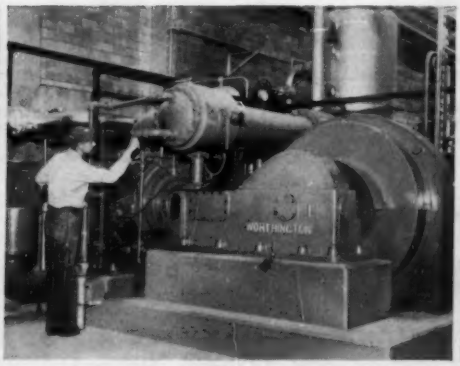


Boiler Feed Pumps. Operating at 3,050 psi, three 9-stage pumps supply the largest generating unit at Eastlake.

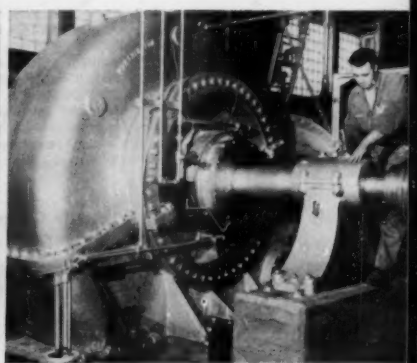
One of the world's most modern, the Eastlake Station of The Cleveland Electric Illuminating Company has a generating capacity of 660,000 kw.



Condensate Pumps. Behind these pumps is the 110,000 sq. ft. condenser serving largest Eastlake generating unit.



Compressors. One of three Worthington horizontal duplex units which supply all of the air for Eastlake's operation.



Circulating Pumps. This main condenser circulating pump, at Eastlake, is of Worthington volute "Mixflo" type.

For more data circle 537 on Post Card

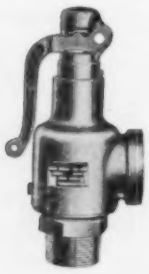
POSITIVE PROTECTION
AT ANY PRESSURE...
specify Consolidated

Get protection you can be sure of — whatever your working pressure. Specify Consolidated Safety Valves. Thousands of installations, in both large and small steam generating plants, attest to their complete reliability under all types of service conditions.

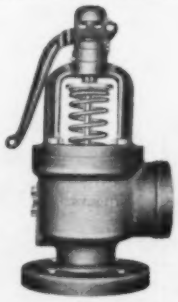
Many Consolidated Valves, with bronze body, are widely used for steam, air and water service; many more are installed in power plants as auxiliaries to Consolidated Steel Safety Valves. The cast iron and steel types are proving their dependability daily on low pressure boilers and those operated at super-critical pressures. The five different Consolidated Valves pictured here are representative types but the line is so complete, proper selection is no problem.

Consolidated Safety Valves are ruggedly built for long service life. Each type incorporates the fewest possible working parts for greatest efficiency. Precision craftsmanship assures positive, tight closing after operation. Through skillful engineering, valve adjustment and maintenance are made simple and easy. All these essentials contribute to outstanding performance, safety and economy.

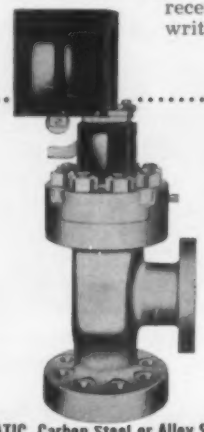
Just send us details of your particular service requirements and you will receive correct valve recommendations. Or write for Catalog 700A.



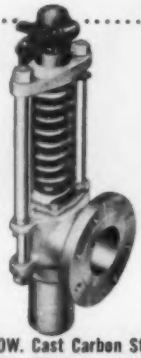
TYPE 1551. Cast Bronze Body. For package-type and fire tube boilers, air tanks and other classes of unfired pressure vessels. **Sizes:** ⅜" through 3". **Pressures:** up to 300 psi. **Temperatures:** up to 450° F.



TYPE 1511. Cast Iron Body. An all-purpose safety valve for steam generator service. Cuts cost per pound of steam discharged. **Sizes:** 1½" through 6". **Pressures:** up to 250 psi. **Temperatures:** up to 450° F.



ELECTROMATIC. Carbon Steel or Alloy Steel. An electrically actuated relief valve for boiler service. Operable automatically, manually or cut out of service by setting remote control switch. Supplements spring-loaded safety valves — conserves power and increases efficiency of steam generating plants. **Sizes:** 2½" through 14". **Pressures:** up to 2500 psi. **Temperatures:** up to 1100° F.



MAXIFLOW. Cast Carbon Steel or Cast Alloy Steel. A safety valve with the greater discharge capacity and shorter blowdown demanded by high pressure, high temperature steam generators. **Sizes:** 1½" through 4". **Pressures:** up to 2500 psi. **Temperatures:** up to 1050° F.

TYPE 1415. Cast Steel Body. For water tube boilers, mechanically fired fire tube boilers, accumulators, unfired pressure vessels and pipelines. **Sizes:** ½" through 6". **Pressures:** up to 900 psi. **Temperatures:** up to 900° F.

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario.

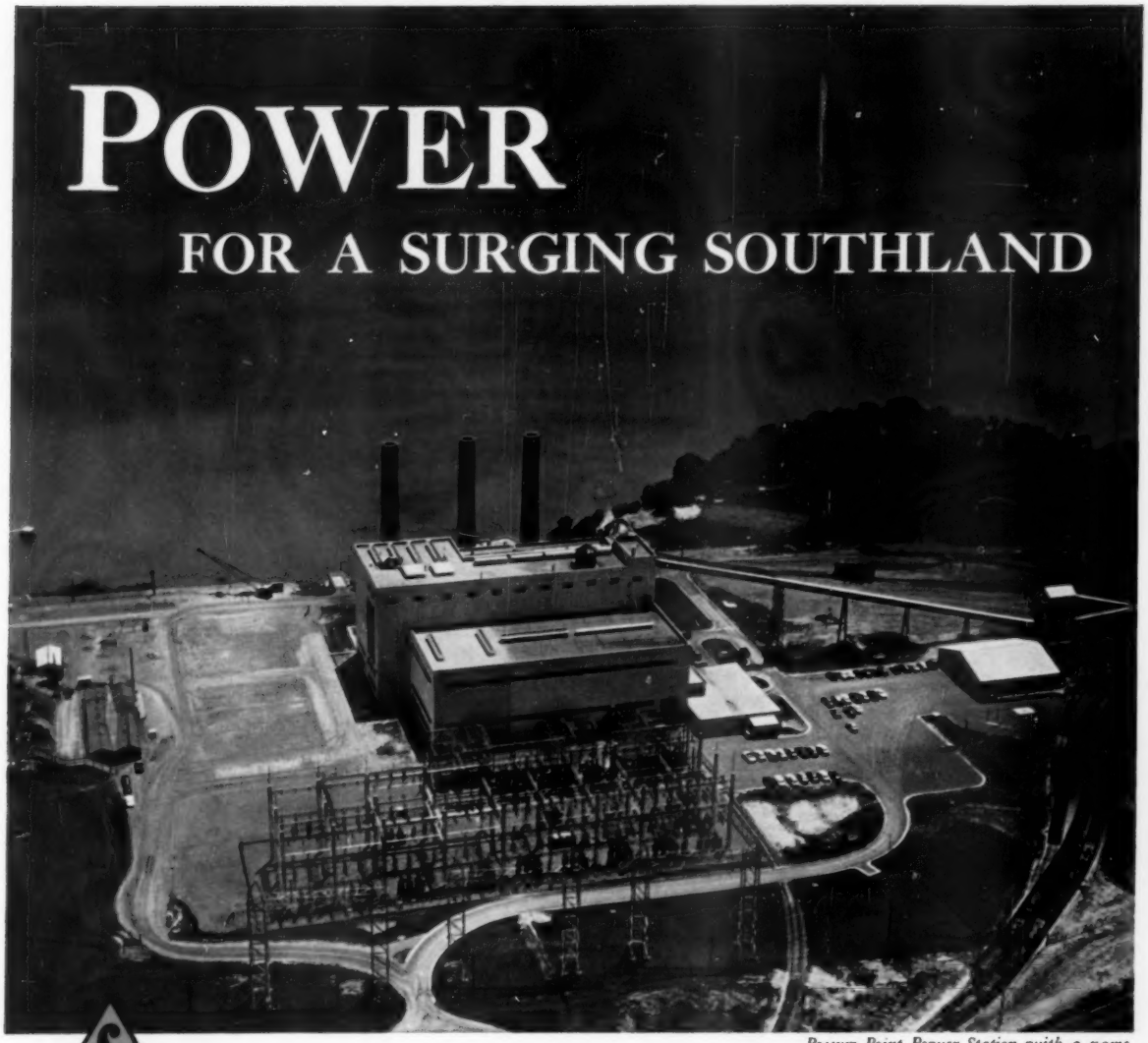
CONSOLIDATED SAFETY VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, CONSOLIDATED SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more data circle 538 on Post Card

POWER
FOR A SURGING SOUTHLAND



Possum Point Power Station with a name plate capacity of 220,000 kw is located on the Potomac River near Quantico, Virginia

The third generating unit of the Possum Point Station of the Virginia Electric and Power Company—designed and built by Stone & Webster Engineering Corporation—went on the line in mid-1955, with a name plate rating of 100,000 kilowatts.

The Engineering Corporation is presently installing four 150,000 kilowatt units in three other generating stations being designed, constructed or extended for this client for commercial operation in 1957, 1958 and 1959.

These additional power facilities are examples of the forward looking steps being taken by Virginia Electric and Power Company to satisfy the rapidly expanding power requirements of the VEPCO system.

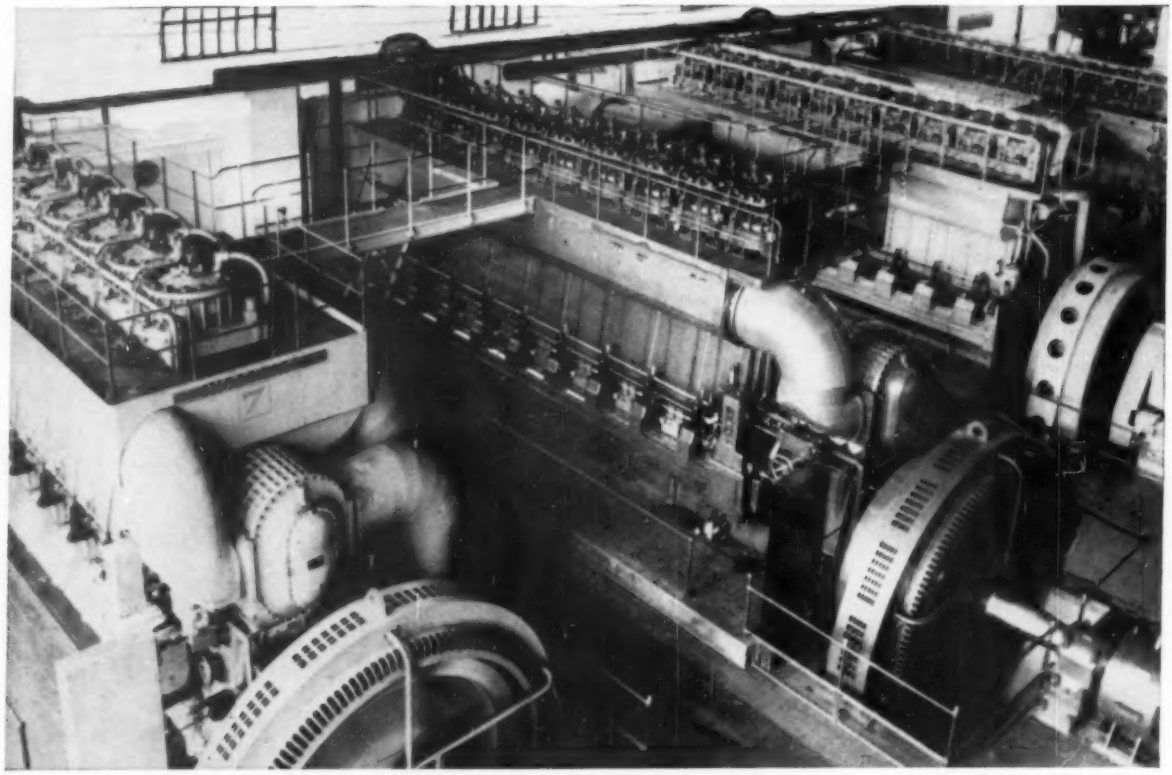
Write or call us for information as to how our experience can be of assistance to you.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY of STONE & WEBSTER, INC.

New York Boston Chicago Pittsburgh Houston Los Angeles San Francisco Seattle Toronto

Look to **COOK** for Better Rings!



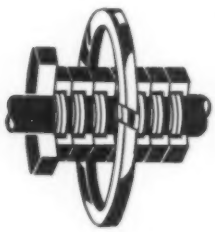
After 25,037 operating hours... Cook rings good for 10,000 more!

HERE'S the result of a cylinder inspection by Rockville Centre, N. Y., municipal power plant officials. It's a report on their No. 8 Diesel unit after almost three years of continuous operation.

"While several rings were replaced in Grooves 1 and 2, Cook rings in Grooves 3, 4, 5 and 6 could run for another 10,000 hours! And cylinders averaged less than .001" maximum wear per 1000 hours of operation."

Light-tight Cook Piston Rings prevent scuffing and blow-by . . . conform perfectly to the cylinder wall because they are re-turned as a final manufacturing process. In addition, Cook rings are tensioned by an exclusive, gentle "squeezing" process that guarantees constant, uniform tension — *for life!*

For complete information on Cook Piston Rings and name of nearest representative, write: C. Lee Cook Company, 914 South 8th Street, Louisville 3, Kentucky.



C. LEE COOK COMPANY

A Subsidiary of Dover Corporation

Rings and Packings Since 1888

For more data circle 540 on Post Card

You don't pay for sludge like this when you buy Morton Purex Salt

When you buy Morton Purex Salt, you get high purity evaporated salt that is made in a controlled-particle size to prevent packing and channeling. None of your freight bill or purchase price goes toward paying for shale and sulphates . . . insolubles like those shown on the filter pad above. (And the cost can be considerable. In every 100 lbs. of any type of rock salt, you are paying for up to 5 lbs. of insolubles.)

With Purex, no time or labor is spent in cleaning out insoluble matter from your brine making system to keep it functioning at peak capacity. For Purex is 100% soluble. Morton Purex will leave no accumulation of material in either brine or water softener tanks. It can be used in bulk wet-storage systems, and in the Morton Model-E Brinemaker.

For more information about Morton Purex Salt, or for free, expert help on any water-softening or brine-making problem, write or wire:

MORTON SALT COMPANY
INDUSTRIAL DIVISION
Dept. PoE-12, 120 So. La Salle Street,
Chicago 3, Illinois

For more data circle 541 on Post Card

CONSTRUCTION NEWS

Phoenix, Ariz. — Arizona Public Service Co has plans under consideration for new generating station near Tempe, Ariz. Proposed facility with an initial capacity of 220,000 kw is expected to be on line by spring of 1960. Construction of the new plant will begin in the early part of 1957 and will bring total electric system resources of the company to 785,000 kw, an increase of better than 500 per cent since 1945. New plant when completed will cost an estimated $28,000,000.

Tucson, Ariz. — Tucson Gas, Electric Light & Power Co has plans under way for expansion of generating facilities at local power plant. Company plans to install new steam-electric generating unit with an initial capacity of 75,000 kw. The unit, now in the process of manufacture by Westinghouse Electric Corp, Pittsburgh, Penna., is scheduled to be placed in operation by May 1958, at a cost of $11,000,000. A 2nd unit of 125,000-kw capacity is planned for the latter part of 1959. Expansion is part of $50,000,000 program announced by the company early this year.

Novato, Calif. — Pacific Gas & Electric Co, 245 Market St, San Francisco, Calif., has authorized plans and work is under way on the replacement of company substation here on Machin and Sweetster Avenues. Cost reported to be $114,000.

Norwalk, Conn. — Connecticut Light & Power Co, 36 Pearl St, Hartford, Conn., has been granted permission to proceed with plans for the construction of a new steam-electric generating station on Manresa Island, off shore from here, by the Connecticut Public Utilities Commission. Construction is planned for early spring of 1957 and is reported to cost in excess of $20,000,000.

Chicago, Ill. — Commonwealth Edison Co, 72 W Adams St, has plans to enter a registration statement totaling $40,000,000 with the Securities & Exchange Commission. Proceeds from the proposed sale will finance a portion of company's projected $600,000,000 construction program through 1959. Property additions this year will cost an estimated $140,000,000 and $180,000,000 next year. Company has completed and under construction 6 new generating units with a generating capacity of more than 1,415,000 kw. Plans also include a 180,000-kw nuclear power plant scheduled to be completed in 1960.

Lexington, Ky. — Square D Co, 6060 Rivard St, Detroit, Mich., has announced plans for the construction of a new plant for the manufacture of electrical equipment on 29-acre site recently acquired. Ground breaking ceremonies will be held soon for manufacturing plant of 150,000 sq ft scheduled for completion late in 1957. Cost of new facility reported to be $2,000,000. A boiler and boiler house along with plant equipment and machinery, will represent an additional outlay of $1,000,000.

Luke, Md. — West Virginia Pulp & Paper Co, 230 Park Ave, New York 17, N. Y., has authorized the expenditure of $50,000,000 for major paper mill expansion at local site here. Expansion represents the largest single undertaking of the company at any one location and will, when completed in mid-1959, transform the Luke Mill into one of the most modern and efficient in the country. A new turbine and boiler will be installed to furnish more power and facilities will be increased for stock storage and refining, coating, calendering, finishing and shipping.

Fergus Falls, Minn. — Otter Tail Power Co, 125 Mill St, S, has plans under consideration for power plant addition at company's Hoot Lake Steam plant. Installation of a steam-electric generating unit with an initial capacity of 50,000 kw is planned at a reported cost in excess of $10,000,000.

Pleasant Hill, Mo. — Missouri Public Service Co, Hout Bldg, Warrensburg, Mo., has authorized expansion of company's generating facilities at Ralph Green Generating Station here. A new power plant is planned at an estimated cost of approximately $3,750,000. Along with increased generating facilities, company plans to extend transmission lines and improve other operating facilities.

Falls City, Neb. — City Council of Falls City has plans under way for extensions and improvements in municipal steam-electric power plant, with installation of equipment for increased capacity. Cost reported to be $500,000. Fulton & Cramer, 922 Trust Bldg, Lincoln, Neb., consulting engineers.

Las Vegas, Nev. — Southern Nevada Power Co, 109 S Second St, has arranged financing in the amount of $4,000,000, proceeds of which will be used to pay for company's construction program now under way. Generating capacity will be increased, as well as distribution lines and other operating facilities.

Newark, N. J. — Public Service Electric & Gas Co, 80 Park Place, has authorized the filing of an application with the State Public Utility Commission to arrange financing in the amount of $83,000,000, proceeds of which will be used in connection with present expansion and construction program of generating and distributing facilities at Ridgefield and Linden power plants now under construction. Estimated construction costs of these projects approximates an investment of $238,000,000. The Ridgefield power plant will be completed in late 1958 and the Linden plant in the fall of 1957.

Newburgh, N. Y. — Central Hudson Gas & Electric Corp, Poughkeepsie, N. Y., has authorized plans for the addition of a new electric generating unit at company's Danskammer Point Steam Power Station near here. New installation, 3rd at the plant, will have an initial capacity of 138,000 kw and will increase station's total capacity to 278,000 kw. The unit is to be placed in operation by late 1959 and is reported to cost in excess of $22,000,000. General Electric Co will build the turbine-generator and Combustion Engineering, Inc, the boilers.

Charlotte, N. C. — The Duke Power Co, of Charlotte, along with the Carolina Power & Light Co, of Raleigh, the South Carolina Electric & Gas Co, of Columbia, and the Virginia Electric & Power Co, of Richmond, Va., are formulating plans for the construction of a new atomic power station in either North or South Carolina, under the name of a new organization called the Carolinas-Virginia Nuclear Power Associates, Inc. Companies mentioned have subscribed a total of $100,000 for preliminary work on the new project. Estimates of the plant's size or cost of construction are not as yet available, but will be announced as project progresses.

Canton, O. — Ohio Power Co, 301 Cleveland Ave, SW, has registered with the Securities & Exchange Commission, a proposal for company financing by sale of stocks and bonds in the amount of $28,000,000, proceeds of which will be used to pay in part short term bank loans and for property additions and generating improvements.

Stratton, O. — Ohio Edison Co, Akron, O., has authorized plans that will double the size of its new steam-electric generating station, now under construction. Plant's power output will be increased from original capacity of 340,000 kw to more than 680,000 kw. Company plans to place on line first two 170,000-kw generators in late 1958 and 1959 and to place the additional units in operation in 1960 and 1961. Additional units will add another $62,000,000 to the cost of this project for a total of $116,000,000 when in full operation.

Portland, Ore. — Pacific Power & Light Co, Public Service Bldg, has plans under consideration for a combination hydro and thermal power site on the Coquille River in Oregon, approximately 90 miles north of the California border. The hydro project capability is estimated at 67,500 kw while the possibility exists of using coal from a deposit nearby for a proposed 100,000-kw steam-electric generating plant. Company has filed applications with the Oregon Hydroelectric commission and the FPC for preliminary permits to investigate the proposed site, located on the south fork of the Coquille River, at Eden Ridge. Estimated cost $30,000,000.

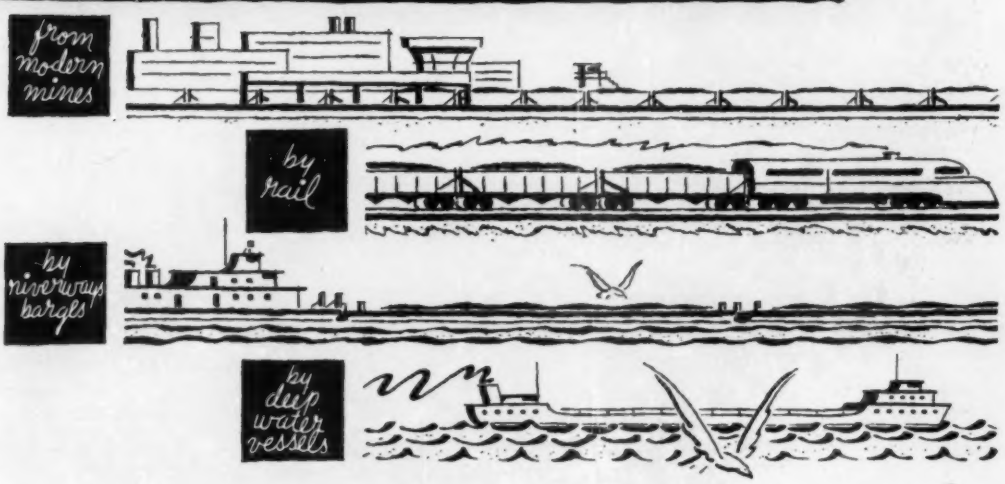
Portland, Ore. — Portland General Electric Co, 621 SW Alder St, has authorized plans for construction of a dam on North Clackamas River and additions to plant facilities at Faraday, Clackamas County. Contract for the work has already been let to the Guy F. Atkinson Co, 10 W. Orange Ave, San Francisco, Calif., and work will get under way soon. Cost reported to be $8,288,429.

Dallas, Tex. — Texas Power & Light Co plans to arrange financing in the amount of $22,000,000, proceeds of which will be used to retire short-term loans and to support present construction program. Improvements are planned in company's power plants and systems, including power substations, transmission lines, and other work.

San Antonio, Tex. — Public Service Board of the City of San Antonio has plans under way for new additions and improvements to municipal power plant and distribution system, to cost about $1,525,000. Work, supervised by own forces, will include increased generating facilities, overhead and underground distribution lines, and additional transformers.

a trust fund of coal

FOR INDUSTRY'S FUTURE NEEDS!



With industry's estimated power needs increasing 500 percent every 25 years, the Peabody-Southern Coal Companies are steadily expanding coal production now exceeding 20 million tons annually. New ultra modern mines and preparation plants are being added to keep pace with the increasing energy demand. Some 2 billion tons of reserves offer ample tonnages to support the Peabody-Southern expansion program. *These tremendous resources are strategically located in leading fields providing economical delivery by rail, by barge, or rail-to-water to all Mid-America. Protect your heavy investments in power plant and manufacturing facilities.

Let Peabody-Southern's vast reserves and modern mining facilities safeguard your future growth and productivity.

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EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 135–136 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—STORAGE BATTERIES are compact, long-lived

Ranging in sizes smaller than a cigarette lighter and from ½ to over 150-amp-hr capacity, these miniaturized nickel cadmium sintered plate storage batteries are said to provide exceptionally high instantaneous currents. They are reported valuable for switch tripping and closing, particularly in compact, unattended substations and in severe climatic conditions. These batteries are designed to deliver momentary discharge currents as high as 25 times rated amp-hr capacity. They are capable of repeated cycle service and have useful capacity in −40 to 165 F temperatures, says manufacturer, and they require little maintenance and can be stored indefinitely in any state of charge without deterioration or fear of freezing. Corrosive fumes are not given off, and pressure release plugs prevent electrolyte spillage, it is noted.

Differing from company's pocket plate storage batteries, which contain active materials in perforated steel pockets, these new batteries contain plates composed of porous sintered nickel impregnated with nickel and cadmium oxides. The electrolyte is a solution of potassium hydroxide. Cell containers are plastic. Nickel Cadmium Battery Corp.

2—DEMAND RECORDER produces its own punched tape record

This digital demand recorder is designed to automatically produce a punched tape record of watt-hour demands. This record can be read visually or processed by company's automatic tape translator

operating a card punch such as the IBM 526. Used in load research work, this equipment enables utilities to get up-to-date information on system load characteristics rapidly and inexpensively. The recorder operates from the standard contact making mechanism on the watt-hour meter. It is an electro-mechanical device with few close tolerances, and claimed accurate to ± 1 count in 400.

The recorder consists of three basic mechanisms: a pulse counting mechanism, a paper punching and transport mechanism and an interval timer. Contact closures from the contact mechanism in the watt-hour meter are added up in the pulse counter. At the end of the demand interval, the punching mechanism is actuated and the watt-hour demand punched on paper tape. The tape is then advanced and the counter zeroed. This action is repeated for each demand interval, producing a punched tape record of watt-hour demand. Catalog 58-40 gives data. Fischer & Porter Co.

3—SHEAVE for V-belt drives on low horsepower jobs

One- and two-groove Magi-Key Sheaves are offered for quick and easy adjustment of this manufacturer's Texrope V-belt drives in A and B sections. For low horsepower applications, the new sheave is designed to provide for increased maximum design horsepower. For example, company notes, a Magi-Key Sheave, the same size as a former two-groove B section cast iron adjustable sheave, will handle about three times more horsepower.

It is explained that in this new sheave, keys transmit all rotational torque, i.e., from shaft to hub and hub to discs; set screws do not bite into threads. Flexibly joined set screw and key serve to give a positive lock between movable discs and stationary hub, and because the key and set screw always remain joined and in place, they cannot drop out during adjustment or move out of alignment. Bulletin 20B8524 gives data. Allis-Chalmers Mfg. Co.

4—INTERRUPTER SWITCH to eliminate external arcing

The MKR-40 Powerupter is designed to permit safe interruption of load, magnetizing, and charging currents up to 600 amp, without danger of external arcing or flame. Switches combine features of a standard group-operated vertical break switch and an interrupter of rugged construction, without sacrifice of any switch design features or characteristics. Double acting mechanism serves to assure instant arc extinction, either in opening or closing circuit. Powerupter switch is available in voltage ratings from 7.2 to 34.5 kv, in continuous current ratings of 400, 600, 1200 and 2000 amp. Delta-Star Electric Div., H. K. Porter Co., Inc.

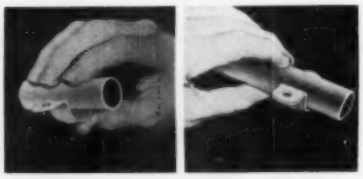
5—ARMORED PIPE for handling corrosive fluids

Impervious carbon and graphite pipe and fittings in this company's Karbate line are now available with an external armoring to protect against accidental breakage. A strong glass fabric bonded to the pipe not only armors and strengthens it, says manufacturer, but in case of breakage, it remains intact, holding line pressure and preventing gross leakage. Connections to the flanged fittings

are made through a protective metal housing, which isolates fittings from external mechanical stresses caused by misalignment or piping expansion or contraction. Armored pipe is available in 1- to 4-in. diam, in lengths to 9 ft, with flanged or plain ends; and fittings, in 1- to 4-in. pipe sizes, are available as 90-deg elbows, tees, couplings, and flange collars. National Carbon Co., Div. of Union Carbide and Carbon Corp.

6—METAL STRAPS snap on to pipe and conduit

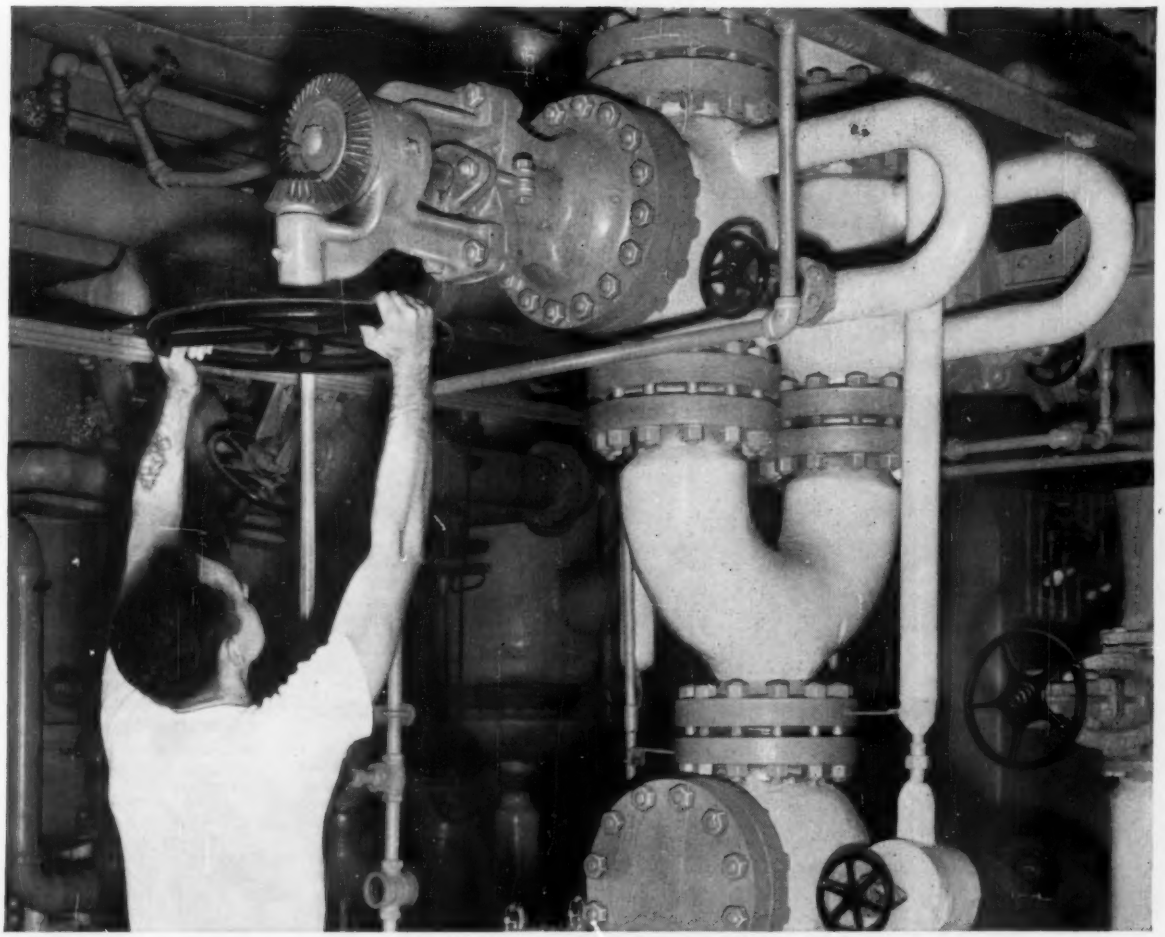
It is claimed that this strap permits neater, faster installations because it doesn't have to be held in place, and is particularly good for overhead or hard-to-reach jobs because it can't drop off.



According to manufacturer, further savings can be made by using these straps and spot welding for installation to steel frame work. Secret of the "snap" is a bump inside the strap. As the strap is pressed on, the bump causes a slight springing action which holds the strap in place. Ribbed construction adds to the snap and provides rigid support of conduit or pipe. Straps are made of steel, zinc plated after fabrication. They come in six sizes from ½ to 2 in. for thin-wall conduit, seven sizes from ⅜ to 2 in. for rigid conduit and pipe. Holub Industries, Inc.

7—FUEL OIL HEATERS are high efficiency, safety type

Paracoil Thermofilm Fuel Oil Heaters are announced as safety-type units featuring 100 per cent counterflow, a safety barrier of heat transfer liquid between oil and water, and no electric warning system The heaters are claimed to deliver more gallons per hour at rated oil exit temperature, within a given temperature range, than comparable fuel oil heaters. Use of extended surface on heating tubes and straight tube construction, oil in shell, water in tubes, providing high counterflow, contribute to improved heat exchange, it is noted.



Here is 14-year proof of Crane low-cost valve performance on feed water

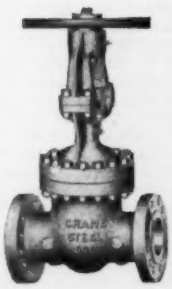
How does a modern utility hold down valve costs?

Central Power & Light Co., Corpus Christi, Texas, has proof of one way to do it: through the rugged dependability of Crane valves like the one shown above.

Fourteen years ago, Central Power installed this Crane No. 76XR valve on the feedwater pump discharge line at its Nueces Bay Station in Corpus Christi, Texas. The valve is a 6-inch gear-operated gate type. Consider its record: since 1942, this Crane valve has been handling feed water at 600 psi., 400° F. Maintenance? *None whatsoever*—the valve hasn't leaked once in 14 years, and is closing as tightly and smoothly as the day it went on the line.

In selecting your all-important valves, don't be misled by outside appearances. What counts in valve performance are *inside*—precision machining, superior materials, expert assembly and testing. That's why Crane valves are preferred throughout industry—and why Crane has been a leading valve manufacturer for over a century.

For full information on the big, complete Crane line, contact your local Crane Representative or write to address below.



CRANE VALVES & FITTINGS

PIPE • KITCHENS • PLUMBING • HEATING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

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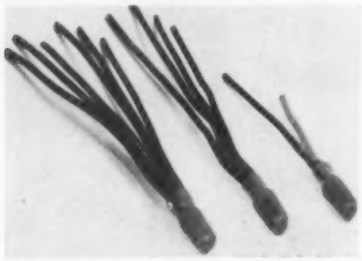
The heaters come in five sizes, and installation costs are said to be reduced because of smaller size, reduced weight and absence of electrical wiring. Catalog 60-N gives details on these units. Davis Engineering Corp.

8—WIRE CONNECTOR makes solderless, insulated splices

Scotchlok Type R Connector is reported to make solderless, ready-insulated splices in one step without tools, providing a vibration-resisting pig-tail splice that holds regardless of thermal or mechanical changes. Manufacturer says this connector is approved by Underwriters' Laboratories for high and low voltage building (1000 v maximum) and



fixture (600 v maximum) wiring. It consists of a cone-shaped coil spring within a steel shell to prevent crushing in crowded junction boxes. The vinyl insulating jacket — molded over the unit — features a triangular cross-section for a better finger grip. It also includes a skirt at the bottom to protect the wires and prevent flashover.

In use, the connector is simply screwed on the ends of the wires to be spliced — the cone-shaped spring construction providing threads and gripping the wires under tension. The pre-insulated connector is reported suitable for use on wire sizes from No. 10 to No. 16 AWG in 64 possible combinations. Minnesota Mining and Mfg. Co.

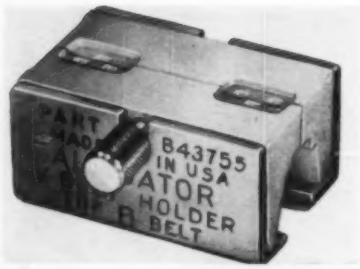
9—VENTILATOR-HEATER features sectionalized design

Nine unit combinations are offered in the Torrivent line, ranging from a basic model supplying untempered make-up air to a deluxe model providing heating, ventilation and humidification. The deluxe model includes an insulated and baffled discharge plenum with insulated enclosure for motor mounting, fan section and coil with attached face and bypass section, and a combination filter-mixing box. Outside air is brought into the model through a wall intake box featuring chevron rain baffles and a protective screen. The Torrivent is especially designed for use in large buildings requiring ventilation with heating.

Engineered to deliver large air volumes quietly and economically, the Torrivent has a louver fin discharge grille adjustable for air discharge patterns. Capacities range from 1150 to 36,000 cfm of air delivery and from 50,000 to 1,900,000 Btu. Other features include a fan for operation at extremely low noise level; compact casing keeping height and width of units at a minimum; and removable panels. Typical process uses of these units include curing-drying, fog removal, exhaust of contaminated air, moisture control. The Trane Co.

10—FASTENER TOOL makes up V-belts of any size

This handy pocket size V-fastener tool lets you make up V-belts of any length much quicker than heretofore possible, it is announced. The low cost of the tool will enable many small users of V-belts to keep a few feet of open-end V-belting plus the tool on hand to make fast emergency replacements. The tool, or holder as it is called, is made for B and C Section V-belts. Bulletin V-219 gives more information. Flexible Steel Lacing Co.



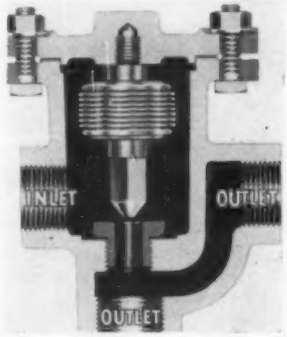
11—CONTROL CENTERS save space, offer easy access

Featuring space saving, accessibility and rigidity, the Bulletin 6200 Type W Control Centers are available in Type A, B, and C construction with NEMA 1 or NEMA 1-gasketed construction. Being narrower than company's previous design, these control centers actually occupy less space. And space required around an installation is also reduced because no access from rear or sides is required for inspection or servicing of components, including horizontal and vertical bus.

Basic vertical unit of the new line is only 20-in. wide, manufacturer states; yet it can accommodate six NEMA Size 2 starters with ample wiring space. Heavy gage steel is used for rigidity and points where load carrying ability is required are independent of the shear strength of screws. No hinge wiring is required and the door can be closed and latched. Clark Controller Co.

12—THERMOSTATIC TRAPS for steam pressures to 300 psi

Of cast semi-steel, cast steel or cast bronze construction, these bellows thermostatic steam traps are designed for installations requiring: a wide variation between start-up and operating load, frequent shutdowns and start-ups, large amounts of air elimination on start-up or during operation. Freeze-up danger has been decreased by providing traps with bottom outlet. Made in three series, each trap is fitted with an orifice



that operates the entire pressure range from 0 gage to maximum rated pressure, without adjustment. Traps are available for steam pressures to 300 psi and temperatures to 500 F. Inlet and outlet connections range from ½ to 2 in. Optional piping, angle or straight-through, is available on the cast semi-steel traps. The traps are reported freeze-proof when vertical outlets are used. Bellows are bronze or Monel. The Clark Mfg. Co.

13—PRECISION CLEANER for steam, compressed air

According to manufacturer, this cleaner separates moisture and entrainments until the steam or compressed air is as close to 100 per cent dry and clean as testing methods can evaluate. A multi-stage device, it includes many stainless steel separating units in series. The cleaner removes all line scale, mineral scale, rust, oil, dirt and liquid slugs, it is claimed. It is suggested for use with high pressure boilers, exhaust steam used in process work to feedwater heaters, beyond aftercooler in compressed air systems, steam for evaporators. Three standard types are available for line diameters to 12 in. Bradshaw & Co.

14—LIQUID METERS offer larger capacity, longer life

Utilizing the basic operating principle of company's standard Rotocycle Meters, these new models feature a crank-type linkage for gear control. Three models provide flow capacities from 400 to 1000 gpm. By means of a control plate and control arms in place of gear arrangements, this new linkage cuts down the number of parts, manufacturer explains; it makes for stronger control of vane positioning and therefore increases capacity and life expectancy. Also, simplicity of measuring element parts is reported to make these meters easier to keep in proper timing. The new crank-type rotors are interchangeable with rotors of Rotocycle Meters already in use. Bulletin OG-411 provides details on these meters. Meter and Valve Div., Rockwell Mfg. Co.

15—PVC PIPING with uniform pressure rating in all sizes

Schedule PR-150 is light wall polyvinyl chloride pipe with a uniform pressure rating in all sizes. Its generally thinner wall and larger inside diameter give it greater flow capacity than company's previously introduced Schedule 40 and 80 in the same nominal pipe sizes. There are two basic types: PVC 1, with high chemical resistance and maximum working pressure of 150 psi at 75 F, and PVC 2, with high impact strength and a rating of 125 psi at 75 F. These two working pressures are constant in all pipe sizes.

This pipe, a rigid unplasticized material, comes in eight sizes from ½ to 4 in. Wall thicknesses range from between 0.050 and 0.230 in. Pipe is furnished in standard 10- and 20-ft lengths with plain ends. A line of socket solvent cement fittings is available for use with this pipe. On an installed cost basis this pipe is reported to compare favorably with conventional threaded piping sys-

unblemished safety record

For more than 40 years, Cochrane Multiport Relief Valves have served industry with a spotless record of unfailing operation.

Not once in all these years have these valves failed to open to atmosphere to protect personnel and valuable equipment against too high pressures!

Reason for this remarkable record is their unique design. Unlike ordinary relief valves, Cochrane Multiport Relief Valves automatically e-a-s-e open under excess, undesired back pressure and bleed off only the exact unusable quantity that caused the overpressure, and then gently and tightly close—without blow-down, back surge or vapor hammer!

Cochrane Multiport Relief Valves are made of various materials to satisfy maximum operating and corrosion conditions. They function equally well whether designed for saturated or superheated steam, air or gas. Their corrosion resistant, "vapor cushion" valve discs will not rust, freeze, or stick.

For complete details write for Publication 5200.

NOTE: *Cochrane Multiport Relief Valves are adaptable to check, spillover and other services.*

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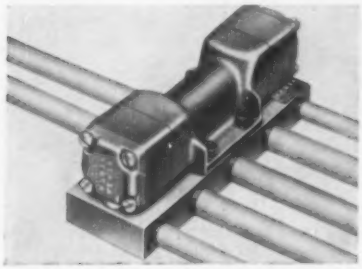
tems in iron pipe or galvanized. It is fabricated on standard metal and wood working equipment. Alloy Tube Div., The Carpenter Steel Co.

16—ALUMINUM PAINT takes temperatures to 1700 F.

C-I Extra High is announced as an aluminum paint capable of withstanding temperatures up to 1700 F without blistering or burning. It is composed of a clear silicone base with special aluminum flake pigment, a combination said to air dry to a bright finish in about 30 min — and, when heated, to virtually fuse with the surface upon which it is applied. According to manufacturer, C-I Extra High forms a metal coating that resists moisture, corrosion, mild acids, alkalis and oven fumes. It is suggested for use on condensers, heat lines, ovens, compressors, engine heads, and, because of its heat resistance, on many surfaces formerly considered unpaintable. It may be applied by brush or spray gun. Chem Industrial Co.

17—CONTROL VALVES for limited space installations

Manifold Mount Control Valves are available in 2, 3, 4 and 5-way types in sizes from ⅛ to 1 in. NPT. They are especially designed for those installations where space is at a premium and speed



of removal and reinstallation are required for uninterrupted production. According to company, all piping can be installed, connected to manifold plate, and even purged before installation of valve itself. Valve is then simply bolted into place on manifold plate. The valve proper, being independent of piping, can be easily removed for service or replacement without extensive work. Standard manifold plates (or Sub-Plates) with threaded porting in side or bottom are available in rolled aluminum, but brass or steel plates can be supplied. Versa Products Co. Inc.

18—MOLDED INSULATION has wide temperature range

Kaytherm is a molded insulation for use on steam and heated process piping. It is announced as highly effective low conductivity insulation capable of withstanding pipe temperatures up to 1350 F. Produced in half-cylindrical sections and segments 36 in. long, Kaytherm is declared easy to install, requiring only simple encircling metal bands to fasten two mating sections to a pipe. It can be cut and worked with ordinary tools, and comes in thicknesses from 1 to 4 in. for pipes up to 33-in. diam.

Kaytherm is made by reacting lime and diatomaceous earth under conditions of heat and water to form a hydrous calcium silicate which is bonded together with asbestos fibers. According to company, this chemically stable material has many favorable characteristics of fine concrete such as strength, wear resistance and dimensional stability. Kaytherm sections are described as light in weight, easy to handle. The material is reported flame resistant, insoluble in water. Keasbey & Mattison Co.

19—TURBO-ALTERNATOR provides constant voltage

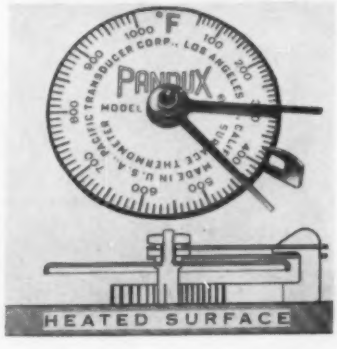
Sixty-cycle alternating current can now be produced for regular or stand-by requirements by a new turbo-alternator that combines mechanical drive turbine, generator, exciter and voltage regulator in a single unit. For use where utility failure might prove disastrous, or where utility service is not available, this unit provides a constant voltage to keep lights bright and motors at peak operation. It is manufactured in 3.75 to 25 kva capacities, single or three phase, and 120/208, 240 or 480 voltages. The unit can be furnished drip-proof, splash-proof and explosion-resistant. The Pyle-National Co.

20—NOZZLE gives operator full control of air flow

Complete air flow control — from a slight puff to a full blast and without jumps from low to high or high to low — is reported possible with this controlled air nozzle. Fabricated of a heat-treated aluminum alloy, it has only two working parts and is made without springs. The removable nose takes a ⅛-in. pipe thread extension. The 45-deg angle of the nose aids in aiming the nozzle. Although weighing only 5½ oz, the unit is described as rugged. It costs less than $2.00 for a ⅜ in. line, and a bushing can be had for ¼-in. lines at slight extra cost. Mortimore Mfg. Co.

21—THERMOMETER shows maximum-minimum surface heat

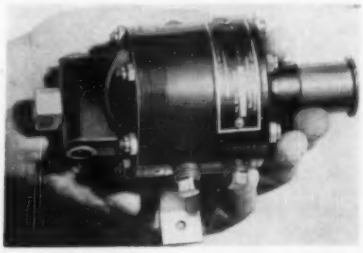
Of stainless steel, with a range of 50 to 1000 F, the Model 575M Maximum-Minimum Spot Check Thermometer has two ancillary pointers which show maximum and minimum excursions over any desired period of time. The maximum and minimum pointers can be re-set whenever a reading is taken. Compact in size, the thermometer's diameter is 1¾ in. It weighs ½ oz. It is designed to read temperature of all surfaces, including heavy sheet metal, large superheated pipes, furnace skins. Besides surface temperatures, it also provides a



maximum-minimum record of temperatures in furnaces and other enclosed spaces, as well as non-corrosive liquids and gases up to 1000 F. An alnico magnet is provided for attachment to ferrous surfaces when the unit is used in vertical position. The Model 575M costs less than $7.00. Pacific Transducer Corp.

22—TRANSMITTER, differential pressure, fixed range type

Hitherto unchecked sources of steam, water and air in departmental consumption can be easily and economically cost-accounted with the 200TD Fixed Range Differential Transmitter, it is announced. And its easy application to plant process control is reported to pay increased dividends where more expensive control equipment is not indicated



cost-wise. Its comparatively lower cost suggests its use for control-engineering complete processes in a plant, such as liquid level, consistency, or low-pressure air or gases (up to 10 psi) requiring sensitive transmission readings to an indicating or recording instrument.

The compact instrument measures only 6½ by 3 in.; weighs 4½ lb. It can be pipe mounted — all connections are ¼ in., internal NPT. A wrench and screw driver can install and adjust it on stream for zero, company points out. Of brass with a diaphragm of Neoprene-impregnated Nylon, the unit has a maximum working pressure of 150 psi, temperature 150 F. Taylor Instrument Companies.

23—OXYGEN ANALYZER is self-contained, portable unit

The Model D2 may be used for measuring oxygen in almost any mixture of gases, it is announced, and the accuracy of the reading is not affected by other gases in the mixture. Its rugged construction is claimed to make it well suited for use in excess air measurements to improve combustion efficiency, in monitoring air leakage in inert systems, and in assuring safe entry into sewers and vessels. Lamp current is provided by two flashlight batteries. No chemicals are used and no special skill needed, it is noted. You merely squeeze a bulb to draw a sample into the analyzer, press the switch, and read the oxygen concentration. Range is 0 to 25 per cent O_2 and accuracy is given as ±0.5 per cent O_2. Arnold O. Beckman, Inc.

24—PRESSURE BURNERS fire Scotch marine type boilers

Syncro/Flame Pressure Burners are designed for economically firing Scotch marine type boilers and similar compact steam generators. It is noted that because of their ability to work against

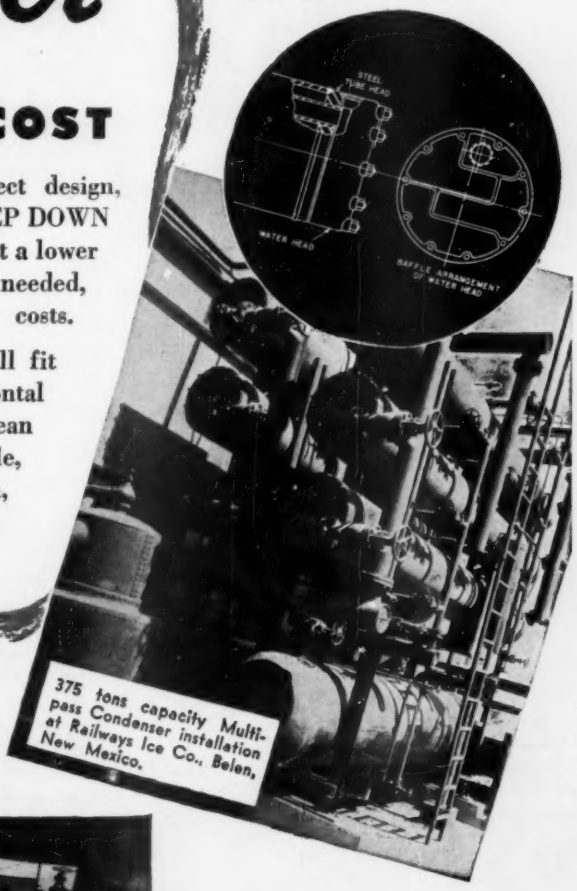
$ave Power and REFRIGERATION COST

Vogt Condensers, because of their correct design, STEP UP the rate of heat transfer and STEP DOWN head pressures. With the liquid delivered at a lower temperature, smaller compressor capacity is needed, saving in original as well as operating costs.

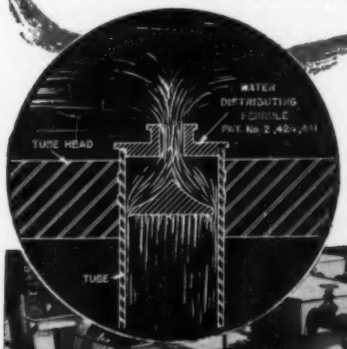
One of the two basic types illustrated will fit your operations exactly. Install Horizontal Multipass (closed type) for use with clean waters. Where the water is hard, forms scale, contains mud or promotes fungus growth, Vertical Single Pass (film type) which can be cleaned in operation, are recommended.

Horizontal Multipass Condensers
(Closed Type)

Water circulated in tubes traverses the length of the unit a number of times as determined by baffles in the heads.

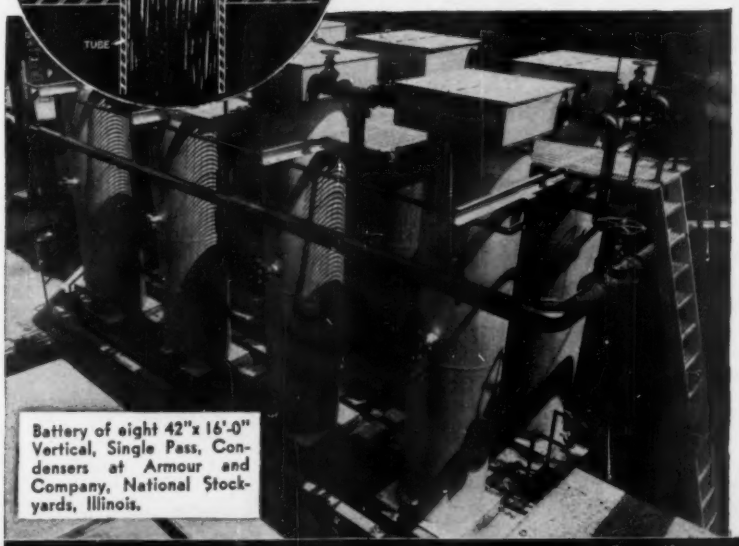


375 tons capacity Multipass Condenser installation at Railways Ice Co., Belen, New Mexico.



Vertical Single Pass Condensers
(Film Type)

Patented ferrules give equal distribution of water to and over the surfaces of all tubes in a unit.



Battery of eight 42"x 16'-0" Vertical, Single Pass, Condensers at Armour and Company, National Stockyards, Illinois.

HORIZONTAL and VERTICAL TYPES SHELL and TUBE CONDENSERS For Every Service

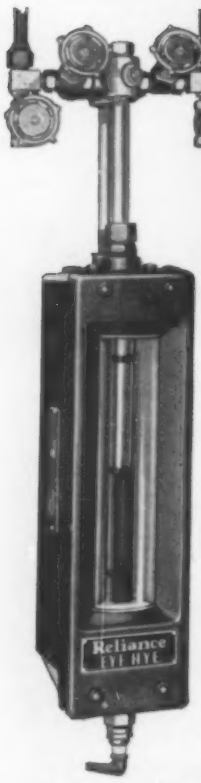
Write For Bulletin RC-2

Address Dept. 24A-RIPE

HENRY VOGT MACHINE COMPANY
INCORPORATED
1000 W. ORMSBY ST., LOUISVILLE 10, KY., U.S.A.
Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.

Vogt REFRIGERATION CONDENSERS

For more data circle 545 on Post Card



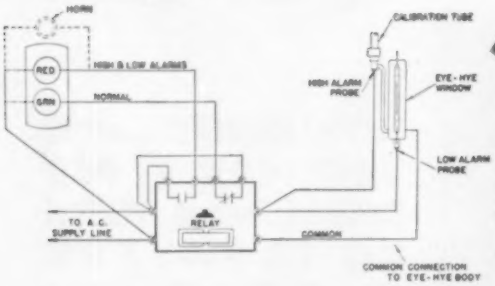
Why not *triple* your boiler water level safety!

Remote reading Reliance EYE-HYE gives you extra sound and sight alarms when you add the Levalarm

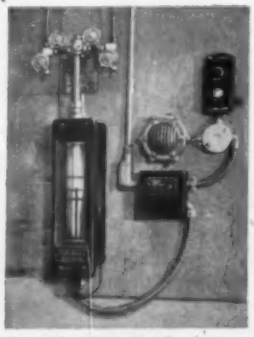
Improve the safety of water level supervision *even more* than EYE-HYE's recognized remote reading advantages; add *extra alarms* at small cost. Reliance electrode Levalarm EA9 augments the illuminated sharp-reading EYE-HYE with vibratory horns or signal lights, or both. They work instantly to alert operators when water levels reach danger points.

The boiler water itself calls the signals! Stainless steel electrodes with teflon insulation pick up a tiny current. Sensitive relays make or break independent circuits that operate the alarms. Levalarms work on low pressure or high.

Reliance Light Indicators, 2-light or 3-light, show green for normal water level — red for dangerous low or high condition. Horns are sturdy noise producers that demand action . . . Low alarm Levalarm can be installed on most EYE-HYEs in service. High alarm facility must be added at our factory. Send EYE-HYE serial number and ask for catalog section C6.



Wiring diagram for high and low alarm hook-up with 2-light indicator and/or horn.



Example of compact hook-up—EYE-HYE with horn and 2-light indicator. The extra signals can be placed any desired distance from the EYE-HYE.

Electrodes used in Levalarm EA9 withstand effects of high temperatures. Require no adjustment.

The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio

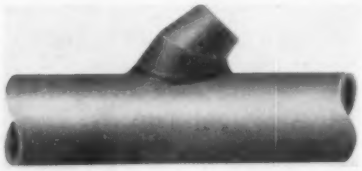
For more data circle 546 on Post Card

combustion chamber back pressures of 3 in. of water or more, these burners do not require a high stack or induced draft equipment.

They are made in several sizes for boilers from 10 to 150-hp ratings, and come in three types: for gas firing, oil firing, or combination gas-oil firing (with manual or automatic changeover). Features announced include two-stage fire, and built-in controls for pre-purge, post-purge, and high-low-off fire with automatic air/fuel ratio settings. The gas and combination burners also incorporate a new circuit said to virtually eliminate possibility of explosion, even under bad misadjustment conditions. Synchronous Flame, Inc.

25—PIPE FITTINGS for the angular branch connections

Elbolets are announced as branch welding pipe fittings for constructing angular branch connections with a full penetra-



tion weld. They are used for making 45-deg connections for directional flow and instrument connections, and for connections into elbows for instruments, drips, and hangar and support connections. Bonney Forge & Tool Works.

26—OFFSET VALVE for instrument piping, general use

The Model 66U-VG is an offset valve with a vertical rising ball check on the downstream side of the seat and with a solid shank connection which, company notes, makes it acceptable as a block or root valve and makes it possible to eliminate the usual block valve. It is pointed out that these valves combine unions, nipples, reducers, elbows, tees, valve and drain valve into one space saving unit, thus reducing the number of threaded connections. They have a double seating stem for repacking under pressure and a pressure bleeder valve and test gage connection. Seats are regrindable and renewable, and the valves have union connection to the gage. Jerguson Gage & Valve Co.

27—MAGNETIC DRIVE with "cross flow" ventilation

This magnetic drive, the Type MDS, replaces two of company's existing lines (Type MDC and MDE). A single basic design is used for all sizes and ratings from 200 hp at 720 rpm to over 2500 hp at higher speeds. A new concept in air cooling utilized and mechanical design changes account for significant savings in space required, compared to previous designs. Length of a 550-hp, 1200-rpm drive, for example, has been cut from 72½ to 48½ in.

Major components of the drive are: A ring member, coupled or belted to a driving motor; and a magnet member, similar to the rotor of a synchronous motor, connected to the load. Magnetic reaction between the two rotors, hence

SOLID WHEEL

spells non-stop turbine performance

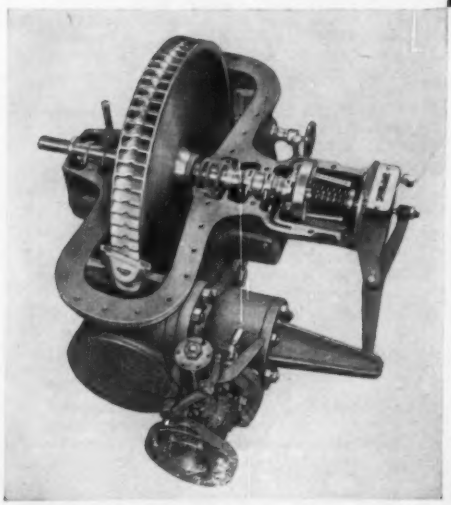
It's easy to see why Terry solid-wheel turbines have been setting non-stop records. They're built for long periods of continuous service.

The rotor, for example, is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out.

What's more, the blades can't foul. There is a one-inch clearance on either side of the wheel and the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets at right angles to the shaft.

You, too, can profit from Terry solid-wheel stamina. Bulletin S-116 gives full details. Send for a copy today.

THE TERRY STEAM TURBINE CO.
Terry Square, Hartford 1, Conn.



Action of steam in a Terry solid-wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

TT-1205

TERRY

For more data circle 547 on Post Card

if

you have any of these troubles:

* **1. SCALE, CORROSION, or FOAMING** *in your boiler operation.*

2. RUST and CORROSION *in your steam and condensate lines.*

3. SCALE, CORROSION, or ALGAE GROWTH *in your cooling or condenser water system.*

4. CORROSION or SCALE *in your hot or cold water tank and lines.*

5. RUST and CORROSION *in your brine or sweet water system.*

6. SCALE *in pumps, water jackets, compressors, coils, lines, or equipment.*

7. SLUDGE and MOISTURE *in your fuel oil supply.*

8. SOOT DEPOSITS *in your furnace combustion areas.*

then . . . let WESTERN prove to you how a specific treatment applied to your specific problem can restore and maintain efficiency and economy in your use of water, steam and fuel. Check the number or numbers of the problems you have in the coupon below. Get full information.

*** for example**

. . . Western's Boiler Feed Water Treatment consists of special formulas, tailor-made to your specific water and operating condition, to eliminate scale, corrosion and foaming.

Over 65 Years of Know-How In the Chemical Treatment of Water

Chemical Treatment for Water Steam and Fuel

WESTERN CHEMICAL COMPANY

717 Washington Street
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Send information on the problems checked:

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City_____ Zone____ State____

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speed of magnet members, is controlled by amount of d-c fed to field poles from a magnetic amplifier control. Speed change is accomplished by turning a control potentiometer, manually or automatically.

Ring member of this drive is a simple, eddy current ring, grooved for maximum heat dissipation. "Cross flow ventilation" takes its name from the fact that cooling air is drawn axially past the rapidly turning ring and is forced down into the grooves. Air turbulence created by peripheral speed of the ring gives a high rate of heat transfer. Fresh air is also forced past the windings of the magnet member. Magnetic drives are used to control speed of boiler draft fans, centrifugal pumps, test stand equipment. Several units of the new drive are designed to control speed of 2500-hp boiler feed pumps. Publication 4400-PRD-232 gives data. Electric Machinery Mfg. Co.

Reader Service Cards on pages 135–136 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

28—SPROCKET RIMS now come in cast Ductile Iron

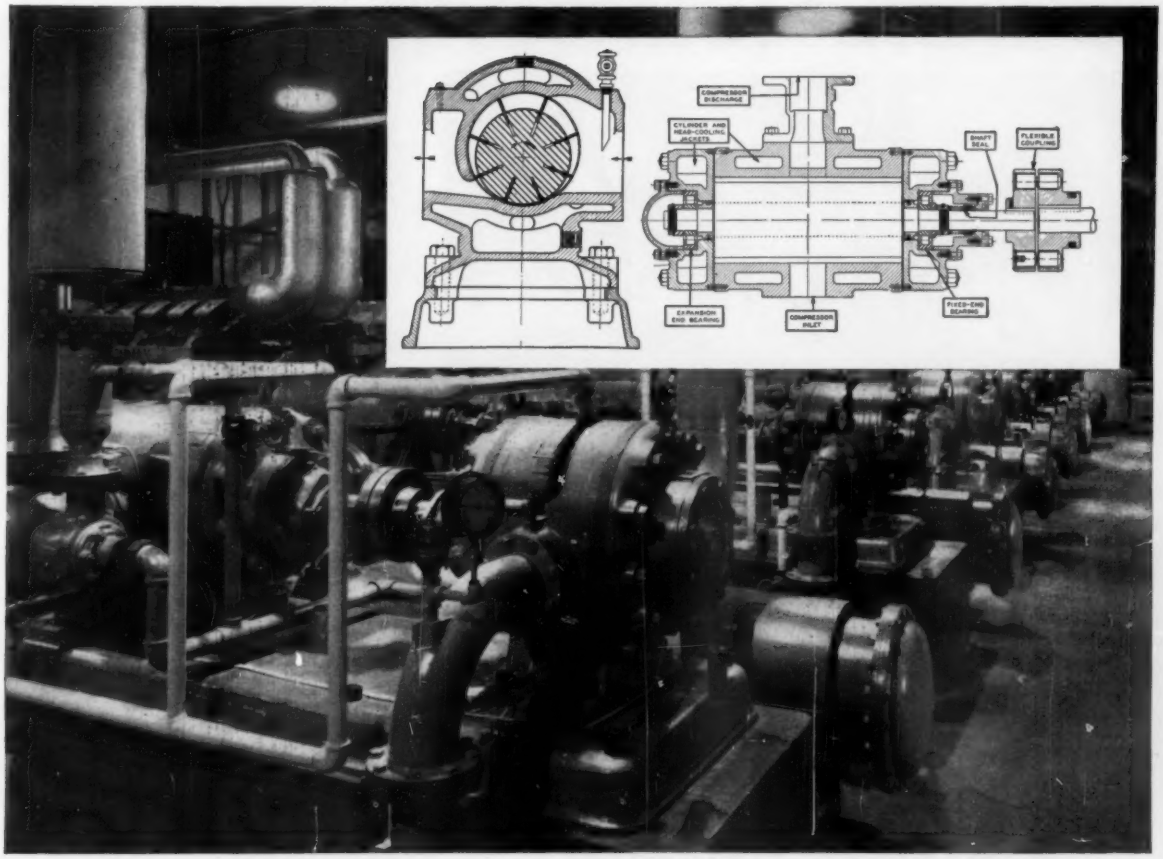
Now offered in cast Ductile Iron are this manufacturer's sprocket rims for enabling easy opening and closing of high overhead or otherwise inaccessibly located valves. They come equipped with chain guide and can be operated from the floor. Ductile Iron is said to combine process advantages of cast iron with product advantages of steel — to be stronger and tougher than gray cast iron, and so ductile it can be bent and twisted. Sprocket rims of this metal are expected to be practically unbreakable in regular plant service. The Babbitt Steam Specialty Co.

29—PIPE COMPOUND now takes higher heat, pressure

Pipetite-Stik, a pipe joint compound now has its maximum temperature rating boosted to 750 F, pressures to 5000 psi. Basically it is the same pipe joint compound in stick form. It is suggested for use on plastic as well as metal threads, on lines carrying water, steam, gas, refrigerants, oxygen, gasoline, butane, propane, brine. Shaped like a large crayon, Pipetite-Stik is applied by rubbing two or three times across the male threads. Manufacturer says it is nontoxic and safe for use on food lines, and that it will withstand vibration or temperature changes, won't rust, and will permit joints to be opened again. Lake Chemical Co.

30—WIRE MARKERS for use in oily conditions

Oil-immersed wire leads are permanently identified with these wire markers having epoxy resin backings, it is claimed — they withstand continuous immersion in Pyranol or 10C transformer oil and operating temperatures to 350 F. They were



HERE ARE 7 FULLER ROTARY COMPRESSORS

. . . in *any* quantity they are an investment in dependability

The wide and continuing acceptance of the Fuller Rotary Compressor in industry is based on a number of unique design features, eminently suited for day in and day out operation in any rugged situation. Indoors or out, its trouble-free operation makes for minimum maintenance and operating costs.

There are 8 good reasons why the Fuller Rotary Compressor enjoys such widespread use—they may easily serve as reasons why your next compressors should be Fuller Rotaries.

1. SIMPLICITY—Elimination of compressor valves, crankshafts, pistons and other moving parts greatly reduces the need for attention, adjustment and replacement. 2. PULSATION-FREE FLOW—Rotary compression eliminates pressure fluctuations and simplifies metering problems. 3. SUSTAINED PERFORMANCE—Blades are held out by centrifugal force, automatically compensating for wear, thus maintaining new-machine efficiency and capacity. 4. NON-VIBRATING—Rotary principle permits a design completely free of reciprocating parts, avoiding basic cause of vibration.

5. COMPACTNESS—Large capacity in relation to size results in lighter weight. 6. EASE OF INSTALLATION—In smaller sizes, no foundation is needed. Larger units need only concrete slab for foundation. Automatic safety controls are incorporated in package. 7. ECONOMY—Few moving parts of the compressor, and their accessibility, reduce maintenance to the minimum. 8. VERSATILITY—Unit can be operated at various conditions. Capacity variation of 50% can be obtained by change of speed with engine, turbine, or two-speed motor drives.

We'd like to send you fully-descriptive Fuller Compressor literature. It's yours for the asking.

FULLER COMPANY, 150 Bridge St., Catasauqua, Penna.

SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION

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PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

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FLEXIBLE **BARCO** BALL JOINTS

NO MAINTENANCE IN 23 YEARS! The arrows point to Barco Ball Joints on two steam lines in a tunnel. At the time of the photograph, two of the joints had been installed twenty-three years without service.

How Barco Simplifies Pipe "Expansion" Problems

1. Many new applications! Every day, interesting new uses are being discovered for Barco Flexible Ball Joints in relieving *expansion* and *contraction* in piping — in Power Plants, Steel Mills, Ships, Petroleum and Chemical Processing Plants, and in Central Heating Systems.

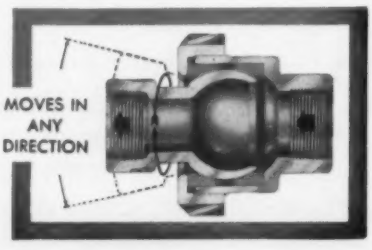
2. Tested and proved in service! Thousands of Barco Joints are now installed in steam and condensate piping. Users report complete satisfaction.

3. No heavy "pipe anchoring" required. Barco Flexible Ball Joints do not develop "end thrust" under pressure—no special provisions are necessary to tie down pipe or joints. Also, they eliminate angular strain.

4. Complete flexibility. Barco Joints do not need to be aligned for straight linear expansion—they handle lines at angles and with perpendicular take-offs with equal ease.

5. Save space! Cut costs! For installation information, ask for a copy of Engineering Drawing No. 10-50165 and new Barco Catalog No. 215B. Joints are available in a wide range of sizes; angle or straight, threaded, flange, or welding ends.

BARCO
Manufacturing Co.
547N HOUGH STREET
BARRINGTON, ILLINOIS



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developed for oil-immersed wire leads in distribution transformers, high-voltage transformers, voltage regulators and specialty transformers, but are suggested for any application where oil conditions are present. The epoxy resin backing is heat activated. Adhesive at each end of the marker holds it tightly wrapped around the wire leads, company explains; the wire leads are baked, activating the epoxy resin into a permanent, solid, oil-proof bond. Mounted on handy dispenser liners, these markers are made to order. Literature and testing sample are offered. W. H. Brady Co.

31—PILOT CONTROLLER for higher temperature application

Model 1100C,D Fultrol is available in standard temperature ranges of 250 to 450 F and 350 to 550 F. However, manufacturer says that any 200-deg range from 50 to 600 F can be supplied. The controller measures 3 1/16 in. wide and 19 3/4 in. long, and is suggested for use where compressed air is the pilot

supply. The thermosensitive tube is stainless steel. A finned "thermal isolator" section serves to keep the valve, adjustments, etc. cool on the high temperature control applications. (A previously announced controller — Model 1100A,B — regulates temperature in adjustable ranges to 350 F and is suited for use with compressed air, water or any clear, low viscosity medium as pilot supply.)

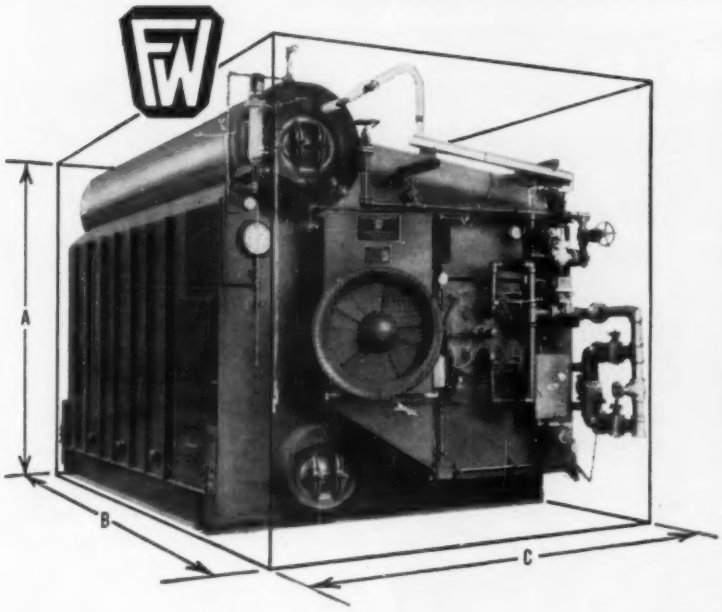
Fultrol instruments are designed to provide temperature regulation of liquids or air when used in conjunction with valves, dampers or other controls. They are installed at the location where temperature is to be maintained, and the sensitive rod-and-tube thermal element is immersed into the medium being controlled. Any change in temperature at the thermal element activates a small pilot valve which, in turn, varies the pressure applied to a control valve or other final regulating device. Pilots are modulating in action, it is noted. Controller may be installed horizontally or vertically. Fulton Sylphon Div., Robertshaw-Fulton Controls Co.

32—PIPE BENDERS are portable, easily operated

Tal One Shot Giant Portable Benders are designed to bend 8-in. pipe, and larger sizes, to any degree up to 90, in a single setting. It takes 3 min. actual bending time, company says, with a 2-hp motor pump, to make a 90-deg bend on 8-in. pipe. Bender can also be used with a 1/2-hp motor or gasoline motor. The frame can be folded into top of hydraulic ram, making it easy to assemble or disassemble and practical for transportation to job. The units are described as the lightest in weight and lowest priced for benders of large capacity, and as easily operated. Similar benders can be had in smaller sizes. An attachment for making 180-deg bends in one shot, for all pipe sizes, is also available. Tal Bender, Inc.

SAVE TIME • SAVE SPACE • SAVE MONEY

. . . with the new Foster Wheeler



PACKAGED STEAM GENERATOR

CAPACITY RANGE AND DIMENSIONS

CAPACITY lb/hr Based on 100 psi, 212F Feedwater and Zero Blowdown		A	B*	C
#6 OIL FIRED	NAT. GAS FIRED			
13,400	12,900	12′ 1¼″	14′ 6¾″	10′ 11¼″
15,600	15,000	12′ 1¼″	15′ 7½″	10′ 11¼″
17,800	17,100	12′ 1¼″	16′ 8¼″	10′ 11¼″
20,000	19,200	12′ 1¼″	17′ 9″	10′ 11¼″
21,800	20,700	12′ 1¼″	18′ 9¾″	10′ 11¼″
24,000	22,800	12′ 1¼″	19′ 10½″	10′ 11¼″
26,200	24,900	12′ 1¼″	20′ 11¼″	10′ 11¼″
28,400	27,000	12′ 1¼″	22′ 0″	10′ 11¼″
30,600	29,100	12′ 1¼″	23′ 0¾″	10′ 11¼″
32,800	31,200	12′ 1¼″	24′ 1½″	10′ 11¼″
35,000	33,300	12′ 1¼″	25′ 2¼″	10′ 11¼″
37,200	35,400	12′ 1¼″	26′ 3″	10′ 11¼″
39,400	37,500	12′ 1¼″	27′ 3¾″	10′ 11¼″
41,600	39,600	12′ 1¼″	28′ 4½″	10′ 11¼″
43,800	41,700	12′ 1¼″	29′ 5¼″	10′ 11¼″
46,000	43,800	12′ 1¼″	30′ 6″	10′ 11¼″

**Varies with method of firing and type of combustion controls. Figures listed provide safe approximation over firing and forced draft equipment.*

HERE's a *complete line* of packaged steam generating units that are built to power boiler standards . . . designed and constructed to offer these important savings.

You *save time* because they are shipped completely assembled, all ready to set on a simple foundation and connect to your fuel, steam and electric power lines.

You *save space* because all packaged units are extremely compact — designed for shipment on standard railroad flat cars. They provide high output in lowest possible installation space consistent with safe rates of heat liberation.

You *save money* because all units are shop fabricated from standard parts, simple to install, and designed for sustained high efficiency and exceptional ease of inspection and servicing.

Construction features include: 36″ steam drum and 24″ water drum — staggered boiler tubes — closely spaced waterwall tubes — effective circulation — light, highly efficient refractory and insulation — wide choice of burners and controls — baffled steam collector.

In addition to the standard units listed here, FW Packaged Steam Generators are also available for design pressures to 1300 psi, with superheaters giving up to 825 F final steam. FW extended surface economizers provide maximum efficiency at these higher pressures and temperatures. For complete information send for Bulletin No. PG-55-3. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

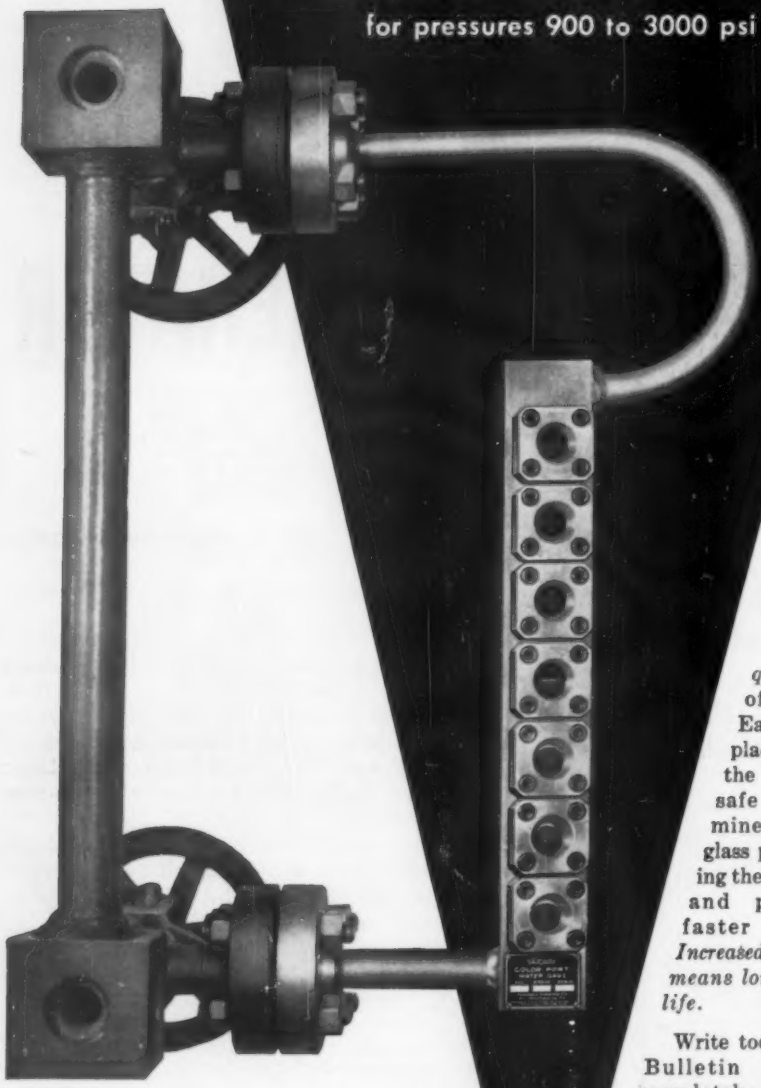
For more data circle 551 on Post Card

NEW FROM YARWAY!

COLOR-PORT

BOILER WATER LEVEL GAGE

for pressures 900 to 3000 psi

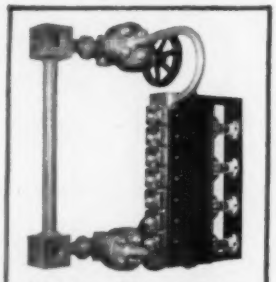


- *two-color readings!*
- *reduced maintenance!*
- *increased availability!*

Now Yarway offers brilliant two-color boiler water level readings, combined with simplicity of gage maintenance and increased availability.

With the new Yarway Color-Port Gage, water space shows green, steam space shows red. A full gage is all green and an empty gage all red.

The Color-Port Gage is *serviced quickly in place* by simple replacement of individual cover-glass assemblies. Each cover assembly is held solidly in place by four socket head capscrews and the "floating assembly" design applies safe predetermined loads on glass ports, reducing thermal shocks, and permitting faster warm-up. *Increased availability means longer service life.*



Side view of Yarway Color-Port Water Level Gage with illuminator, circulating tie-bar and Welbond gage valves.

Write today for new Bulletin WG-1814, completely describing Yarway Color-Port High Pressure Water Level Gages.

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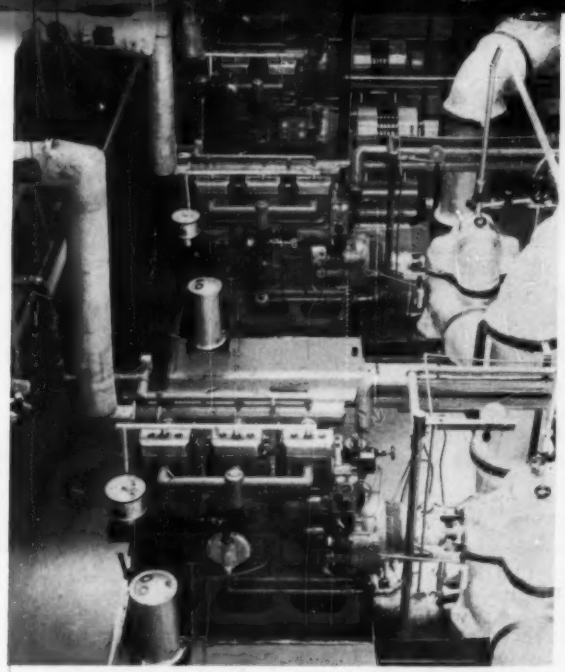


View of engine room at Aurora sewage plant shows line-up of gas engines. Two 6-cylinder engines in foreground drive pumps; two 4-cylinder engines, background, drive generators

Overhaul of a gas engine is an operation that can be carried out satisfactorily by any group of reasonably competent mechanics *provided* that they know what is expected of them and are given the proper direction and job supervision. While this article does not pretend to make experts out of men with no experience, it will help a good crew do better, longer-lasting overhauls

By R. C. HAGENMILLER
Associate Editor, POWER ENGINEERING

How To Overhaul Your Gas Engine

In order to bring this story to its readers, POWER ENGINEERING assigned Associate Editor Hagenmiller to record and photograph all details of the complete engine overhaul shown here. Armed with camera and notebook, he lived right on the job for 5 days to prepare this "how-to-do-it" feature

FIRST QUESTION THAT arose in the original planning of this article was . . . "Where do we get the story?" Your editors began mentioning all the modern gas engine plants they knew about — big plants with ideal conditions, full equipment, and elaborate machine shops. But then the Executive Editor shot this one at us: "That's fine, but what good will such a story do for the little guy who doesn't have ideal conditions and all the fancy equipment? . . . he's the one we're trying to help." That made sense, so we decided to shop around for a medium-sized installation, sort of average, but with a maintenance crew who knew what they were doing.

We found what we were looking for at the well-run Sewage Plant of the Aurora Sanitary District in Aurora, Ill. District Superintendent Walter Sperry, well known in Illinois for his efficient plant operation and maintenance, promised (and gave) full coöperation during the next major overhaul of one of his 20-year old Climax dual-fuel gas engines.

The plant has four of these engines; two 6-cylinder and two 4-cylinder units. The sixes drive pumps, the fours, generators which usually supply all the plant's electrical power requirements. Fuel capability of these engines is somewhat unusual. They are in reality, *tri*-fuel engines. Normally operated on sludge gas from the digesters, they can be switched to piped-in natural gas, or, if necessary, run on gasoline should either of the gaseous fuels be unavailable.

Engine we cover in this article was installed in 1936 and has had several previous major overhauls. A 6-cylinder OHV job with a 6-in. bore and 7-in. stroke, it is rated at at 75 hp at 1000 rpm; average duty speed as a pump drive is governed at 750 rpm.

Selected because it is a fairly typical engine, the overhaul procedures it requires as described in the following pages are also typical. However, all types of engines have their own peculiarities that necessitate special consideration, and reference should always be made to the manufacturer's instruction manual.

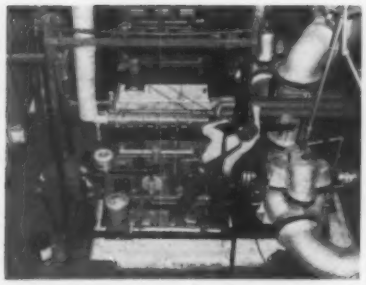


Fig. 1. Bolted-up "A"-frame is erected for securing block and tackle for heavy lifting. Made of 2x6's, pipe, unit has platforms and disassembles for storage

Fig. 2. After oil and water is drained, manifolds are disconnected and removed. If badly rusted, treat nuts and bolts with solvent made for purpose

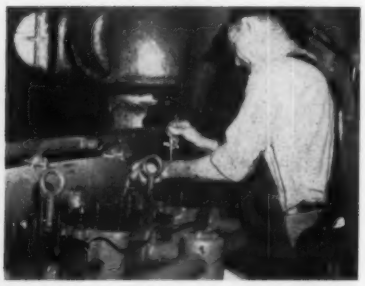


Fig. 3. Remove the rocker arm assembly and intake manifold. Metal tag wired on each rocker assembly helps keep identity for reassembly to same head

DISASSEMBLY

Before actual work is started, complete overhaul job should be reviewed both by supervisors and mechanics who will do the work. Be sure all standard and special tools required are on hand and that parts needed are available. If outside machine work may be necessary, clear job with shop to ensure priority

AS IN ALL MAJOR undertakings, planning and preparation should precede any large scale engine overhaul. There is much to be done before a single bolt is removed. Supervisory personnel should meet with the lead mechanic who is to be in charge of the actual work and go over with him, *step by step*, every phase of the job to determine what repair work can be handled by the crew and what must be farmed out to a qualified shop. When this is known, or estimated, arrangements must be made with the outside shop so that the work can be handled promptly without conflict with other jobs they may have on hand or promised. Scheduling is most important.

Replacement parts must be lined up or obtained if these are not carried in stock. Remember that parts for industrial engines, particularly older models, are not as readily obtainable as are similar parts for automotive engines. You may have to order from the factory gasket sets, valves, valve inserts, rings, pistons, piston pins, or connecting rods. If it is thought that there is a good possibility that such parts will be needed, have these actually on hand before you start.

Check the tool situation. You should have at least one complete set of automotive wrenches in the sizes needed for your engine. Two sets are better, allowing several men to work at bolting and unbolting at the same time. (Some old timers are addicted to adjustable wrenches; forbid use of these knucklebusters.)

Fig. 4. Remove all push rods, keeping them in order, before lifting head from block. Special sling attached to studs used here; avoid damaging threads

Fig. 5. Normal wear of rings on cylinder wall leaves sharp ridge in cylinder at top limit of ring travel; this ridge must be cut away even if cylinder walls are not further processed. Cutter tool must be sharp, properly ground to prevent chattering. Always use ridge cutter *before* trying to remove pistons from top

Fig. 6. These engines have removable cylinder blocks which are removed for reconditioning. Shop will degrease and boil out water jackets to remove scale

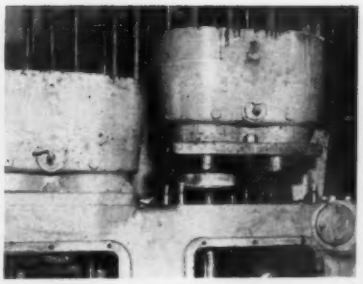


Fig. 7. In this operation, blocks are removed before rods and pistons; other engines may need reverse. Avoid nicks on machined surfaces during handling

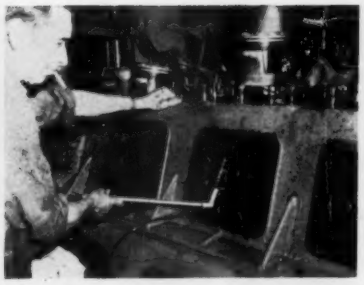


Fig. 8. Remove pistons and rods. Note position of rods and caps so assembly will be same. Be sure rods and caps are both marked as matched sets

Most engines require some special tools or wrenches peculiar to their construction and these should be checked for availability and condition.

Whether you have, or will invest in, such tools as micrometers, cylinder gages, cylinder ridge cutters, etc., will depend on the economics of your situation. In any event, they can usually be rented or borrowed from the shop that handles your repair work — but be sure they will be available to you at the time you will need them.

An excellent plan adopted by many plants with good results is to write out a complete schedule of the overhaul operation in detail — listing every operation from initial oil drain to final start-up. Each item on the list can then be checked off with regard to tools necessary, parts available, repair work likely. It is surprising how often this procedure will turn up a tool, operation, or part not previously considered.

Other items to be provided before starting the work are means of lifting and handling such heavy parts as cylinder heads, blocks, manifolding, or crankshafts. If you have an overhead crane or steel structure to which you can secure block and tackle, there is no problem. If not, a simple "A"-frame structure of 2 by 6's, as shown here, may be the answer. You will need boxes or racks to hold small parts, racks for pistons, rods, and valve train components, as well as containers for cleaning materials and solvents.

Fig. 9. Valve spring compressor used here is home-made outfit that does a good job. Block of wood under valve head holds stem in position while spring is compressed to reach valve spring retainers. Sometimes spring caps stick and resist movement; if this happens, tap them sharply with plastic mallet to loosen fit

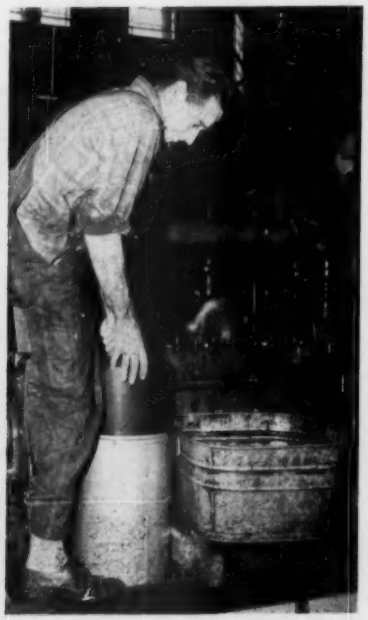


Fig. 10. Oil filter element comes out of container. In this type of overhaul, lubrication system needs complete and thorough cleaning to prevent later ills

Fig. 11. Ring grooves are cleaned by scraping with a broken piece of piston ring; special tool would be better. Oil drain holes are cleaned with drill

Fig. 12. Connecting rods are cleaned up with solvent. Keep the bearing caps and shims as unit. If rods are drilled for oil to piston pin, clean out with brush

Fig. 13. Preliminary cleaning up of a rocker assembly. Be especially careful to remove all sludge or deposits from the inside of hollow rocker arm shafts

Fig. 14. (Left) Wire brush chucked in electric drill helps remove carbon from combustion chambers in head; heads will be sent to outside shop for truing-up of gasket surfaces, replacement of valve seat inserts, and removal of scale from the water jackets

Fig. 15. Hardened valve seat inserts are driven out with a long punch inserted through head ports. Great care must be exercised to avoid damaging seats in head; damage may cause gas leakage. Special tools pull some inserts *

Fig. 16. (Right) Since new valve guides are to be installed in this job, old guides are pressed out. *Note:* Hard deposits on stem of old guide may enlarge hole when guide is pushed out; prevent this by breaking off stem before guide is pressed out

Separate reprints of this picture story on gas engine overhaul will be available to those readers who may wish to have them for educational or training purposes. To obtain a copy, write the Editor, POWER ENGINEERING, 110 S. Dearborn St., Chicago 4, Ill., or note request on postcard elsewhere in this issue

* We are pleased to acknowledge the coöperation of Killian Auto Parts, Montgomery, Ill., for their part in obtaining the photographs in Figs. 15 through 22, and 24 through 26.

QUALITY OF THE REPAIR work that is done on engine components will, in large measure, determine the success of the overhaul job. It is essential, therefore, that the best practice be followed so that the engine will be brought back as nearly as possible to mint condition.

Pistons frequently may be reconditioned and reused unless extensive refinishing of cylinder walls so changes dimensions that the pistons will not be a reasonable fit. But do not waste time reclaiming pistons that are scored or have worn or bent ring lands. If pistons are reusable, soak them for 24 hours in a carbon-removing compound, rinse, then clean away all remaining traces of hard carbon from heads and ring grooves. A special groove cleaning tool is best, but a broken piston ring is effective if used carefully. Clean out oil drain holes in the lower grooves with a drill.

Piston rings should be of type recommended and of best quality — it doesn't pay to experiment.

Piston pins should be replaced and fitted to bushings by either "diamond boring" or honing; reamer fits are not satisfactory, since surface finish from reaming permits premature loosening of the pins.

Connecting rods should be straightened and aligned. If rods are rifle-drilled for oil passage to piston pin, clean passage thoroughly and blow out *from both ends* so that any loosened particles will be dislodged.

Connecting rod bearings, if direct babbitted, should be examined carefully for condition. Very light scoring can be tolerated, but gouged or unevenly colored surfaces should be viewed with suspicion. Unless you are certain that source of re-babbitting is reliable and uses specification babbitt, replace rods with new ones. Babbitt from a common melting pot makes undependable bearings.

Where precision-type insert bearings are used, new inserts of proper size should be fitted. Established bearing manufacturers are best source of information for size and type of bearing to be used; bearing composition varies with engine and type of service.

Crankshaft is vital part and must be carefully inspected for condition when engine is down. Measure all journals and crankpins for out-of-roundness and taper. Generally-accepted limits for out-of-roundness are 0.003 in. for main journals and 0.002 in. for crankpins. Check engine manual for individual specifications.

Within limits, worn crankpins and journals can be reground to a standard undersize and refitted with undersize bearings; in extreme cases of wear, journals may be ground down, then metallized to bring them back to standard. This work must be done with extreme care by fully qualified experts to be acceptable; it is seldom justified on the smaller-sized crankshafts except as an emergency measure.

Fig. 17. Head is surface ground to true up face for good fit with cylinder block; where this acts to increase compression ratio beyond desired extent, use of thicker head gaskets can compensate for metal removed and thus retain original ratio

Fig. 18. After new valve guides have been fitted, valve seat inserts are installed with seat-inserting tool. Inserts must be accurate fit, perfectly concentric with machined seat in head, to hold shape, remain in place, and conduct valve heat

Fig. 19. New valve seat inserts are ground with piloted stone like other valve seats. Seat angles are specified in engine manual or may be obtained from valve manufacturer. Seats may be finished by polishing in with fine compound

Fig. 20. Hydrostatic test of head after shop operations; prior experience showed possibility of leakage from water jackets at valve seats after rework. Water ports are blocked with gasketed plate, head water filled, air pressure applied

Fig. 21. Rocker arms are refaced on fixture attached to valve grinder. Pad faces become grooved after long operation, thus preventing accurate measurement and setting of valve lash. Operation shown preserves original contour

Fig. 22. Valves on this engine were good, required only touch-up on grinder. After refacing, valves were individually seated with fine grinding compound and very light touch. Valve stem ends should also be ground square

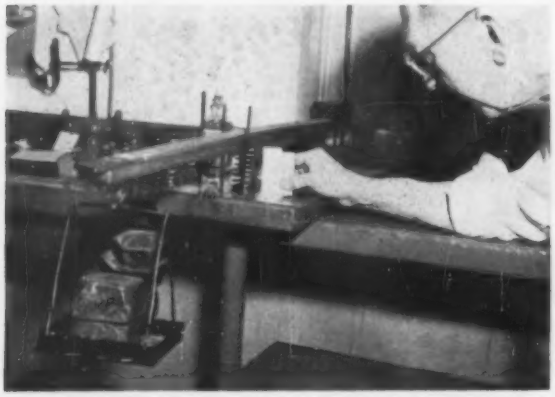


Fig. 23. Fixture devised by Superintendent Sperry to test the equality of inner and outer valve springs. Arm with predetermined load should depress each type of spring no more than that fixed by gage. Weak springs can shorten valve life

Fig. 24. Generator overhaul is part of job. Here, commutator is turned down for truing and finishing surface. Automotive-type armatures, having no center holes in shaft ends, require special rotating armature chucks such as those on this fixture

Fig. 25. Carbon-brush generators usually require undercutting of mica to about 1/16-in. below commutator surface. Align the cutter carefully with mica grooves to avoid cutting into bars; remove any sharp feather edges raised by cutter

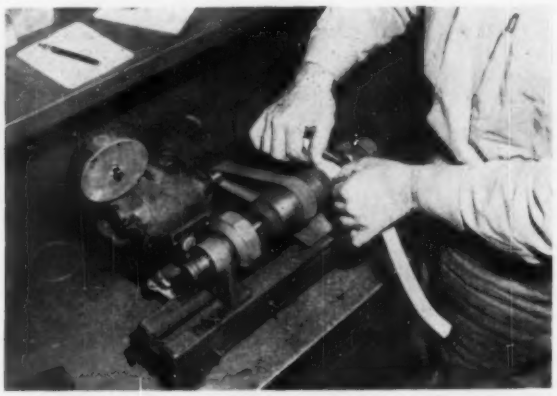


Fig. 26. After truing and undercutting, commutator is finished by polishing with 2–0 sandpaper. *Caution:* Never use anything but sandpaper for this operation; emery cloth must not be used. Blow dust off windings with dry, filtered air

Caution: Regardless of the work done on a crankshaft, it is imperative to thoroughly clean the drilled oil passages. Use a small round bristle brush with a long handle and scrub well. Blow out the holes, from both ends, with dry, filtered air. Any loosened particles not removed will eventually reach the bearings and usually cause early failure.

Once the surfaces are finished, use utmost caution to avoid nicks or scratches — a small imperfection may damage the mating bearing heavily in a short time.

Main bearings are almost always of the replaceable insert type. A number of precautions should be observed if they are installed as part of the overhaul. Aside from selecting the correct size, cleanliness in handling is probably most important. Bearing seats must be absolutely clean, since any particles under the bearing will produce a high spot that causes either reduced clearance or actual interference after assembly that leads to inevitable trouble. Oil holes must match the seat; always compare new bearings with the old to make sure the replacement sets are correct.

Cylinders, or liners if used, are checked for out-of-roundness, taper, or waviness. Liners, of course, can be replaced; cylinders — depending on the degree and extent of wear — can be rebored and honed, lightly honed, or merely wire-brushed to break glaze and permit good seating of new rings.

Expensive cylinder blocks that are badly scored or worn can be brought back to original size by a relatively new method of iron and porous chrome plating.* Such a repair will produce cylinders with a longer wear-life than the original surface. This is a patented process not to be confused with ordinary chrome plating, which is unsuitable.

Camshaft should be inspected for cam wear. Slight roughness on cam faces may be stoned down or polished off with polishing paper of a fine grade. Cam geometry must not be altered in this process, and if scoring is extensive, regrinding will be necessary.

Valve lifters frequently require refacing, especially if the mating cam is roughened. This is best done on a grinder since squareness is important to ensure proper rotation of the lifter during operation. Check push rods for straightness and condition of upper and lower ends.

Other parts to be cleaned and inspected are timing chain or gears, remainder of valve train, and oil pump.

*See: Now You Can Renew Worn Cylinders With Chromium, POWER ENGINEERING, December 1955.

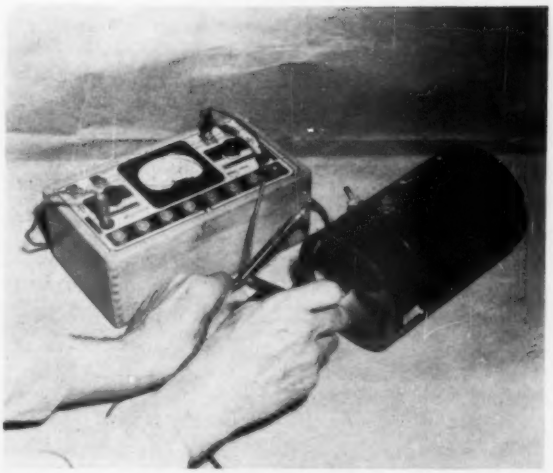


Fig. 28. Ohmeter checks field coils of generator for grounds. Set meter on high resistance scale, place one prod on frame of generator, other on field coil lead. If meter shows any reading, a ground is evident. Better to replace than repair

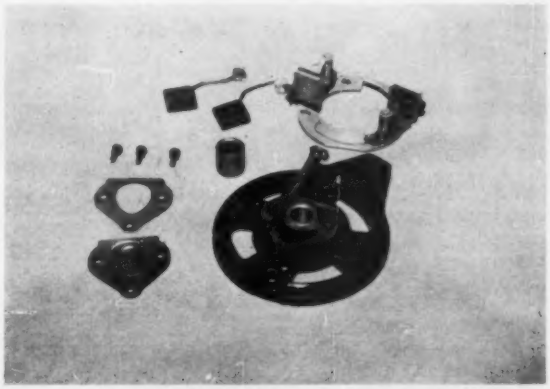


Fig. 29. All parts in commutator end of generator should be cleaned and inspected. If the bushing is worn, press out and replace with a new one; be sure new bushing is not too tight on shaft. Long service usually clogs felt oil wick—replace it

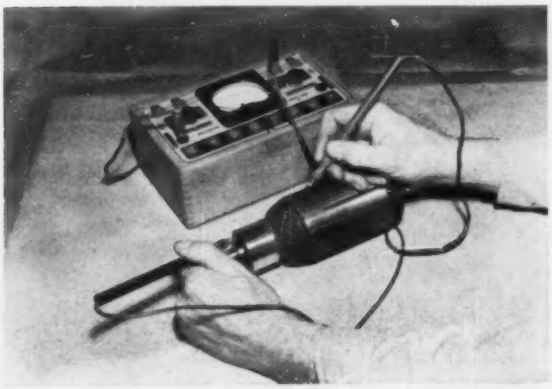


Fig. 27. As a precaution, armature is checked with ohmeter by bar-to-bar test to detect shorted coils. Meter is set to low resistance scale, then resistance between each adjacent pair of commutator bars is read. All readings should be the same

Fig. 30. Drive end of generator has ball bearing—examine carefully for wear. When cleaning ball bearings, never spin bearing with high-pressure air; extremely high speed results from this practice, non-lubricated bearing race may score

ASSEMBLY

Fig. 31. Photo shows how to measure piston ring gap clearance with feeler gage. Actually, gap should be measured with ring at lowest end of ring travel

SUCCESSFUL REASSEMBLY of an engine with new or expertly reworked parts is more a matter of care, cleanliness, and common-sense than a matter of great skill and experience. Although these latter abilities are of course valuable, they count for little if care and cleanliness are neglected or shrugged off as unimportant details. More engine failures are traceable to dirt, grit, and similar foreign matter than to any other single cause.

When work is not in progress, all engine openings must be covered with clean tarpaulins or other lint-free materials. New and reworked parts should be covered or wrapped and temporarily stored away from the immediate working area, which should be kept clean and orderly.

Before reassembly begins, all oil passages throughout the engine should be cleaned and flushed out; wash sludge deposits from crankcase walls and timing gear case.

If cylinders have been bored or honed, more care than usual must be taken to rid the engine of any trace of metal particles. Best practice calls for scrubbing reworked cylinders with soap, water, and bristle brush immediately after completion of machine work; dry, then coat walls with good grade of premium or heavy-duty crankcase oil to prevent rusting. Longer this scrubbing is delayed, the harder it is to remove

Fig. 32. Method of filing ring to keep ends square. Usual gap is 0.003-in. per inch of cylinder diameter; to find actual gap, multiply diameter by 0.003

Fig. 33. Oil piston rings and grooves liberally before applying compressor. Space ring gaps equally around circumference of piston, with no gaps aligned

Fig. 34. Interior of ring compressor should be clean but well oiled. When tightening compressor, tap all around to assist rings to slide into position

Fig. 35. Crankpin is lubricated before inserting piston and rod in cylinder. Bearing cap should be similarly lubricated before installing on rod end to assure lubricant supply in bearing when engine is started and oil lines are still dry

Fig. 36. (Right) Two men are needed to install piston in cylinder; one drives piston, other guides rod end to crankpin to prevent damage to journal surface. Once piston has started into cylinder, go very slowly to avoid sudden drop

the particles clinging to the honing fluid — which gets progressively more gummy as the volatiles evaporate.

Certain amount of fitting on assembly may be necessary — chiefly with piston rings and bearing inserts. Two dimensions to check on piston rings is width, in relation to fit in piston ring grooves, and ring gap, or amount of opening between ends when the ring is in the smallest diameter of the cylinder (assuming there is taper).

Width check can be made by rolling new ring around groove and determining clearance with a feeler gage. Engine manual or ring manufacturer will specify minimum and maximum clearances for your particular pistons. Where ring grooves have been widened to eliminate taper wear, it is sometimes necessary to use thin spacer rings as shims to reduce ring clearance in groove to correct value. On the other hand, if rings are a little too wide to fit into grooves (plus minimum clearance), they can be thinned down by hand grinding.

Thinning Piston Rings

Sheet of fine emery cloth is tacked or cemented down on a perfectly flat plate; piece of board, slightly larger than ring diameter, is made to hold the ring flat, and ring is then carefully ground by hand on the emery cloth. Use circular motion, and keep rotating the work under the hand to grind evenly all around.

Ring gap is generally standardized at 0.003-in. per inch of cylinder diameter; a 5-in. diam cylinder, for example, would call for a ring gap of 5 × 0.003-in., or 0.015-in. total. To achieve this clearance, push each ring into its cylinder, with piston as guide for squareness, until ring is at the lowest end of ring travel — where diameter is smallest. Check gap with a feeler gage. If clearance is insufficient, clamp fine flat (mill) file in vise and file both ring ends at same time, as shown in Fig. 32. This method keeps ends square. Go slowly, and check often to avoid over-filing the gap clearance.

If piston ring installing tool is not available, "thread" the rings down on the piston, one groove at a time. Unless you have a specific reason for not doing so, install rings exactly as instructed by the manufacturer. Note carefully if rings are stamped to indicate top and bottom, but in

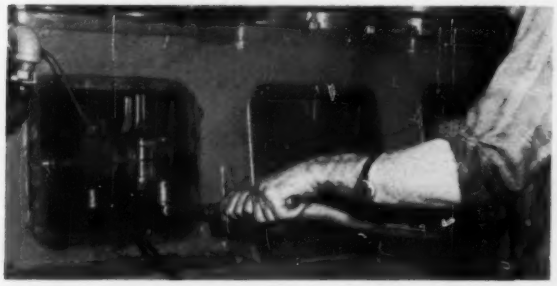


Fig. 37. (Above) When replacing bearing caps on connecting rods, do not tighten until all are in place. If mechanic is not very experienced, use torque wrench to tighten bolts to tension specified in engine manual. Threads must be clean

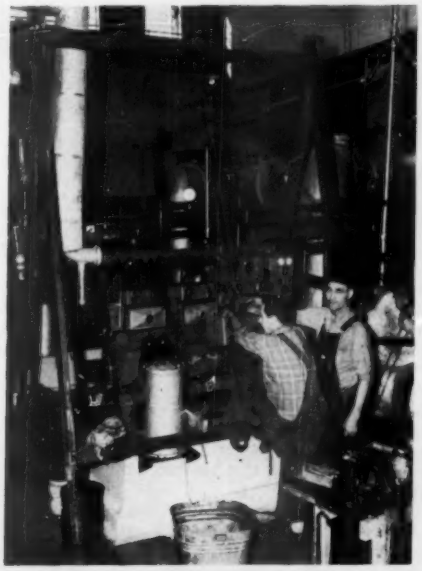


Fig. 38. (Right, above) Reworked cylinder head is hoisted into place by block and tackle on "A" frame. Whether or not gasket sealing compounds are used on cylinder head gaskets is matter decided by experience with each particular engine

Fig. 39. (Below) Here, speed wrench handle is useful for quickly running down nuts on cylinder head bolts before the actual tightening. To tighten, start in center and work out; pull down evenly, in steps, always following same sequence

Fig. 40. (Right) Water-jacketed manifold is replaced. Block and tackle aid in holding unit while bolts are started. It is good plan to coat exhaust manifold bolts with anti-seize compound made for this purpose; later removal will be easier

Fig. 41. Check your engine manual for instructions on correct way to tighten manifold bolts; long single castings may need some freedom to expand

Fig. 42. Valve lash is set with feeler gage. Gage stock in strips of needed sizes is better; gage set is preserved, fresh, unhammered size always ready

ASSEMBLY (concluded)

any event, follow the instruction sheet supplied.

When rings are installed in their proper grooves, space ring gaps equally around piston circumference; avoid placing any gap directly over line of piston pin ends. Lubricate rings and grooves liberally with oil, apply ring compressor and oil again; tighten compressor step at a time, tapping occasionally so rings will slide into place.

Place piston and rod in position in cylinder — making certain that rod is facing correct side. One man uses a block of wood to drive piston into cylinder while another stands by to guide rod end onto crankpin that has been previously lubricated. If piston is stubborn, don't try to pound it in — loosen the ring compressor slightly, *or*, determine if it is already so loose that the bottom ring is catching on the block.

Avoid Crankpin Damage

Under no circumstances permit the rod big-end bolts or edges to nick the crankpin surface; if by chance a nick does occur, wipe the pin dry and carefully polish off any raised spots. (When doing this, it is safest to put an easily removable plug into the crankpin oil hole to prevent metal particles from entering.)

Fig. 43. Overhauled carburetor replaced on intake manifold. If repair kits not obtainable for old carburetor, replace with available universal type

Fig. 44. Ignition wire should be replaced periodically; weak insulation is not always evident. Magneto repair is specialized job better left to experts

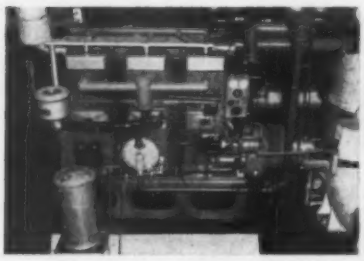


Fig. 45. Completed engine is painted and ready for several additional years of trouble-free service. Good overhaul practice cuts general operating costs

Fig. 46. Supt. Sperry, Assistant Supt. Pfeifer, and Chief Mechanic L. Decker make final inspection, observe initial run-in and declare job "Approved as is"

As soon as piston is inserted, replace the bearing cap — and shims, if used. Tighten cap bolts a little less than snug; when all pistons are in place, go over all the rod bearing bolts in succession, tightening evenly without drawing them up to full tension on the first pass. Next, tap each bearing cap on the crown to settle it in place, then draw bolts to correct tension and replace lock nuts or cotter pins.

Ideally, connecting rod bearing bolts should be drawn up to correct tension by means of a torque indicating wrench, as should other critical bolts such as main bearing and cylinder head bolts. For a torque wrench to function accurately, it is necessary that threads be clean and sharp and the pull applied evenly. Unless you have experienced mechanics who have an exceptional sense of "feel", invest in a torque wrench for best results.

Fit Bearing Inserts Carefully

Fitting new main and connecting rod bearing inserts is a critical job that will have much to do with the life of the overhaul. First, compare new set of bearings with the old set to be sure that they match in general appearance, oil groove design, location of oil hole, and method of bearing retention in seat.

Second, measure crankpins and main bearing journals on crankshaft to ensure that final bearing clearance will be within limits of tolerance for controlling oil throw-off. It has been shown that a bearing with a prescribed 0.0015-in. clearance will throw 25 times as much oil if the clearance is increased by only 0.0045-in.

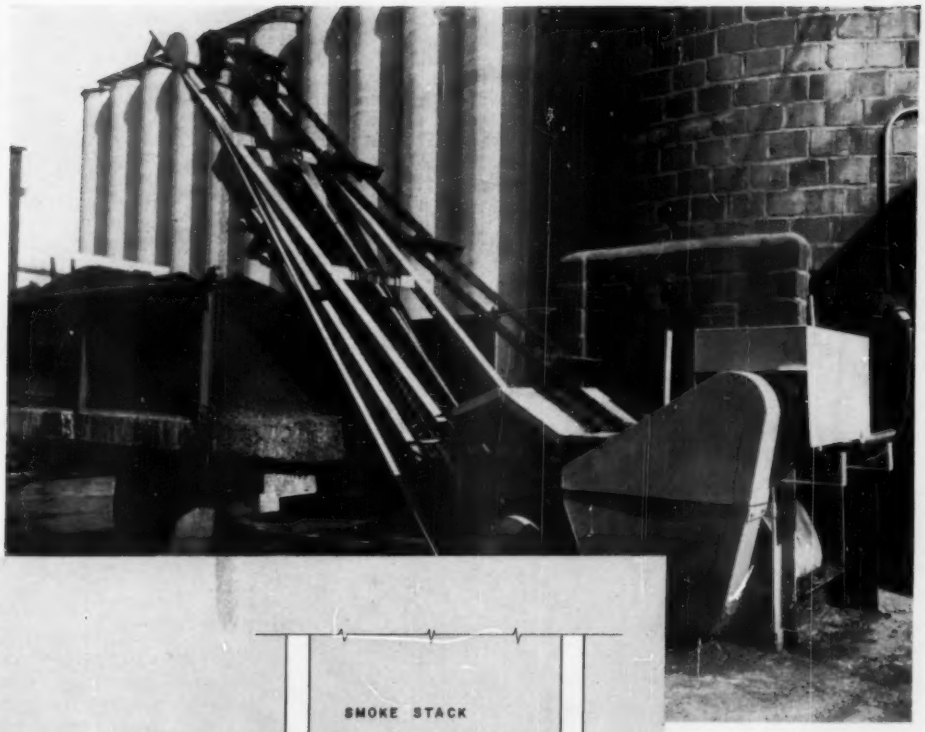
Third, wipe off each bearing and its seat with a clean paper towel or lint-free cloth before placing it in position. Dirt will either raise high spots on the bearing or prevent its seating fully within the bore; if the latter occurs, the half-bearing ends will have too much interference when bolted together and the resultant crushing will push "wrinkles" into the bearing clearance space.

Check Thrust Bearings

Crankshaft thrust bearings, if not provided with mechanical adjustment (at No. 1 main), should be checked for end clearance. As provided, many such bearings have additional thickness on the thrust flanges to permit fitting at assembly. Scrape, or otherwise face off thrust flanges as necessary.

A bearing oil leak tester is an excellent piece of equipment to make final check on bearing clearance and guarantee that lubrication system will function properly. Use of this device will also help prelubricate the bearings and flush out any foreign matter inadvertently left in oil lines.

In the final analysis, a good overhaul will result if you adhere to good practice, insist on scrupulous cleanliness, and avoid "just-as-good" short cuts.



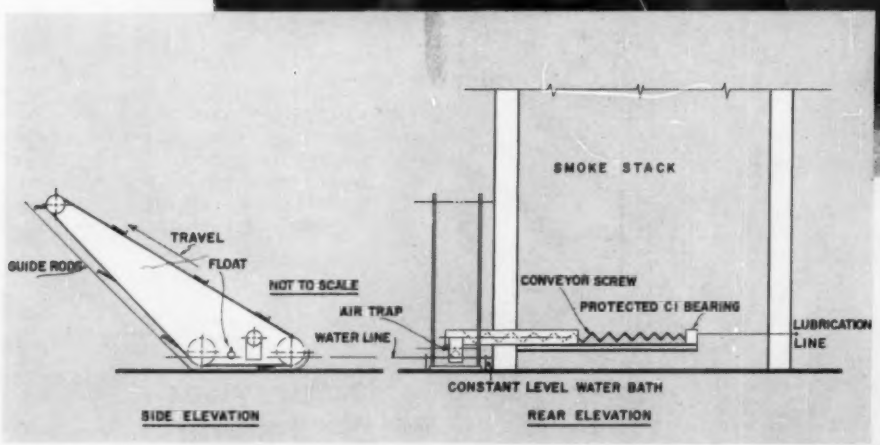


Fig. 1. (*left*) Sectional view through ash disposal unit and stack

Fig. 2. (*above*) Shows unit removing wetted ash from water bath and loading on truck

Homemade Fly Ash Disposal Unit Does Good Job in Small Plant

By HENRY AGNER *

STEAM for our plant is generated by blower-stoker fired furnaces burning low-grade coal which produces heavy fly ash deposits in the base of the smoke stack. We had to use hand labor to remove the ash and load it for disposal at an annual cost of $1900. There was not enough ash to justify purchase of a commercial disposal unit — we averaged about four cu yd daily.

Cleaning presented a safety problem. When the cleanout door in the base of the stack was opened, the draft often resulted in spontaneous ignition of ash in the deposit area. On one occasion the stack belched flame through the cleanout entrance and a man was painfully burned.

As if this were not bad enough, when the stack was cleaned fly ash would escape and blow about the plant and there was danger of it contaminating our product.

These disadvantages gave us enough incentive to design a disposal unit of our own. Figure 1 shows a sectional elevation through the unit and Fig. 2 shows it in operation.

The fly ash disposal unit consists of a tapered stainless steel screw conveyor inserted into the ash deposit area in the base of the stack. See Fig. 1. The ash is withdrawn from the stack by the screw and falls through an air trap into a constant level water bath. The outboard bearing of the screw is mounted in and protected by a sleeve which is attached to the outlet-end sleeve of the screw with a piece of 3 by 3 by ¼ in. angle iron. This keeps the bearings in proper alignment. Note too, that a lubrication line is provided to this outboard bearing.

The air trap and the constant level water bath are extremely important, and the success of the unit depends on them. The water level must be kept above the lower lip of the air trap to prevent the stack from drawing air through the screw discharge. Should this happen, combustion will take place in the stack resulting in temperatures which may damage the screw. In addition, the ash may bridge, making it necessary to clean out the base of the stack before the unit will function.

Critical too, is the area of water

*Development Engineer, Igleheart Brothers (Jell-o Division of General Foods Corporation)

surface exposed to the ash inside the air trap since the ash wets very slowly. On the basis of our experience with this unit, approximately 1 sq ft of water surface exposed in the air trap would allow us to remove approximately 12 cu yd of fly ash in a 24-hr period. To operate at this capacity, the unit would need to run constantly except for short periods of shutdown to unload the truck or trailer receiving the wetted ash.

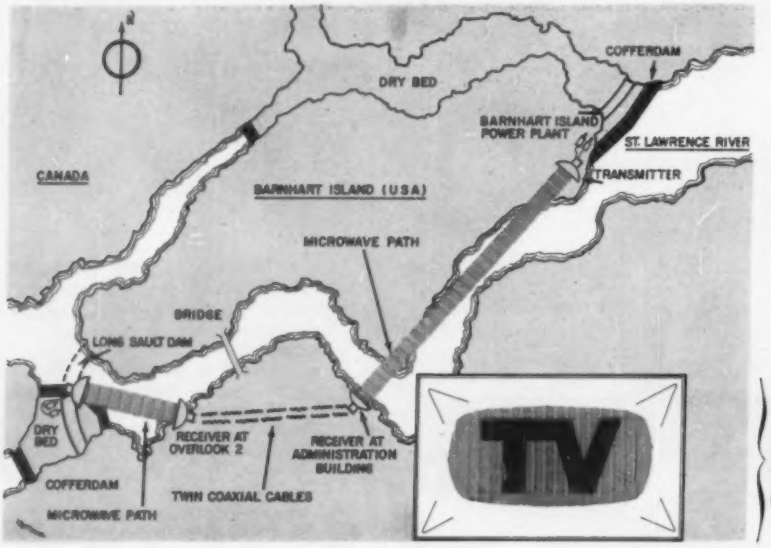
To maintain a uniform level of water in the bath, a conventional flat-type valve was utilized. The float, however, must operate under certain conditions to remain trouble free. It should be placed so that the carrying lugs removing ash from the water bath will move under the float to keep material from accumulating there and causing the float to stay shut. Entering water should flow over the float to keep it clean, since small amounts of ash will escape from the air trap, come to the surface of the water, and accumulate on the float. Unless this ash is removed periodically, it will cause the float to sink. The float, of course, must be oversize to compensate for the added weight of the water flowing over it.

The remaining portion of the unit is devoted to removing the wetted ash from the water bath and disposing of it. It is illustrated in Fig. 2. This portion of the unit is easily constructed. All sprockets and chains exposed to the wet ash should have hardened surfaces.

As indicated in Fig. 2, the 3 by 3 by ¼ in. by 15 in. angle iron used to form the carrying units are attached to an 8-in. pivoted arm. As these carrying lugs pass over the upper sprocket, they pivot and drop down striking the guide rods. This breaks loose any ash tending to stick. The guide rods place the lugs back into position before they re-enter the water bath.

We have the unit depositing the ash into a trailer equipped with a hydraulic lift. The only labor involved is that required to attach the trailer to a pickup truck, tow it to a dump and unload the trailer.

The unit has proved itself to be comparatively trouble free. Construction and installation of the unit cost approximately $1800 — in 1953. We feel that it has saved us over $1500 a year in direct labor costs alone, plus the fact that it has eliminated both a safety hazard and a housekeeping problem.



St. Lawrence power project site showing TV camera locations at Barnhart Island power plant and at Long Sault dam with microwave and coaxial cable paths back to receivers in the Administration building from where the resident engineer can supervise construction

TV Supervises St. Lawrence Construction

ON THE GIANT St. Lawrence power project, television is being used for the first time in dam construction history to supervise work taking place over an area of many miles. The system is proving so successful that it may well be the forerunner of similar applications on other hydro sites and general construction projects.

As explained in our article in the March 1956 issue of POWER ENGINEERING, describing the St. Lawrence Power Project, much of the work on this job is concentrated in the construction of two massive dams located some miles apart. One is the Barnhart Island Power Plant Dam, which is 3230 ft long, and forms part of the main power plant of the project, and the 2350 ft Long Sault Dam.

At each site, two television cameras are used. One is a fixed camera that looks across the entire dam site, and the other, equipped with a telephoto lens, slowly scans an arc of approximately 120 deg. The fixed cameras are on for 30 seconds and alternate with the scanning cameras which have a one minute cycle. The television signals from the cameras are transmitted by microwave relays to television receivers in the administration building where the resident engineer can watch both construction sites. The arrangement of microwave transmission and coaxial cable is shown in the diagram.

The resident engineer is in contact with the work sites by two-wave radio, and can route supplies, equipment, and manpower as needed.

For several reasons, microwave links are used rather than coaxial cable for transmitting the television signals. The path of the signals has to cross water at several points, and cable would either have to be buried or hung on poles. This would be unsatisfactory owing to the possibility of accidental damage while maneuvering large construction equipment. The microwave system is less costly and is not affected by crossing water or the movement of heavy machinery.

Between the administration building and Overlook 2, where there are no such difficulties, coaxial cable is used for transmitting the signals, as shown in the diagram.

Substantial savings in time and money have already been made by the use of this television system. A few minutes observation of the television screens is equal to several hours travel to the construction sites, and emergency rearrangements in supply of men and materials can be made very rapidly by means of the two-way radio system. If necessary, the location of the television units can be altered quite easily.

The television system was installed by Raytheon Mfg Co, General Precision Laboratory, N. Y., and the Power Authority of the State of New York.

Nuclear Power Plant Heat Exchangers Are Different

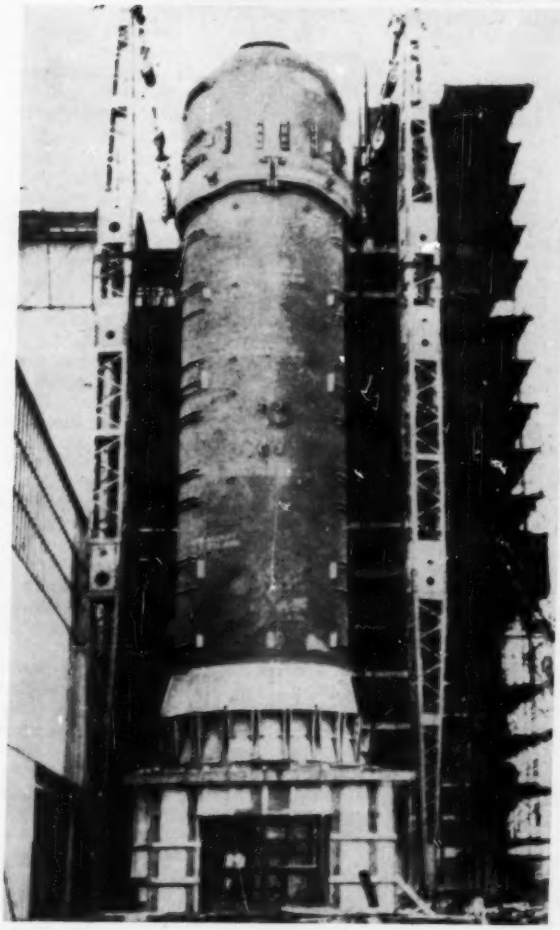


Fig. 1. One of Calder Hall's steam raising towers, a heat exchanger where CO_2 gives up heat to change water to steam

Fig. 2. Shows general view of Calder Hall, Britain's first nuclear power plant

Though not responsible for design or manufacture, a power engineer needs to be familiar with the construction of his equipment if he is to purchase wisely and operate efficiently. It is becoming increasingly evident that the nuclear reactor, heat exchanger, and other associated equipment will soon be as much part of a power engineer's business as boilers, turbines, and condensers are now. This article describes some of the ways in which the heat exchanger for the nuclear plant differs from the conventional heat exchanger we know today, and gives some idea of the many new problems the power engineer is going to meet in the use of this new form of power generation

By DR. S. BARON*

IF ATOMIC ENERGY is to succeed as another source of economic power, a large measure of the success must come from the heat exchanger industry. Probably no other single piece of equipment is required to make such large strides and exceed to a comparable degree its present day technology. Nature has succeeded in combining perhaps the worst properties in the materials constituting fissionable fuels, counter balanced by their one great advantage — heat generation. Since heat removal is the central problem in a nuclear power plant, then, obviously, good heat exchanger design is of paramount importance.

There are essentially two basic arrangements for removing the heat generated by the fission reactions. The earliest and the most widely developed method is the heterogeneous or fixed bed design in which the coolant is circulated through the fuel for heat removal. The coolant leaves the reactor and is used either for direct power generation or for heating a secondary fluid which is used for power generation.

The second arrangement, of more recent origin, involves the recirculation of dissolved (homogeneous) or suspended fuel in a coolant which is heated in the reactor and cooled in an external heat exchanger. A fluid fuel system with the heat exchanger

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in the reactor is somewhat of a compromise.

In the case of the heterogeneous reactor, the heat transfer is an integral and important part of the reactor design. It is, therefore, necessary to give careful consideration to the thermal and nuclear properties of the materials if a critical chain reaction is to be achieved. In the circulating fuel system with the heat transfer external to the reactor, it is possible to separate the thermal and nuclear problems. However, such a system tends to make the hydraulic, corrosion, and mechanical problems somewhat more severe than in the heterogeneous type.

Uranium metal reacts rapidly with air and water. In addition, it has the troublesome property of permanently stretching under thermal cycling conditions. If it is to be used in the metal form as in the solid fuel reactor it must be alloyed with materials to improve its properties. The materials must be carefully selected to keep the neutron loss due to parasitic capture as low as possible. Otherwise, it is necessary to add more U^{235} in order to maintain the chain reaction. At \$15–\$30 per gm for U^{235} (12–24 times greater than gold), it would be very costly. In addition, in order to prevent the release of toxic fission products, it is necessary to clad the alloy. The cladding material must then have good mechanical, thermal, and nuclear properties.

Corrosion and erosion of exchanger materials is more severe in reactor application. The need for high heat transfer rates is usually met by increasing the coolant velocities to values above 30 ft per sec. These high velocities mechanically break the protective film and appreciably increase the corrosion rate. Even a small amount of corrosion product will become radioactive and be deposited in the accessory equipment which may not be properly shielded. In liquid metal coolants where temperature differences are high, mass transfer corrosion may occur where the metal is dissolved in the high temperature section of the reactor and deposited in the cooler parts.

Many materials become radioactive as a result of neutron capture. This is especially true of the circulating fluid fuel systems where a small percentage of the neutrons (called delayed neutrons) are produced outside of the reactor. Therefore, maintenance and repair become very difficult. In the Homogeneous Reactor (HRT) presently being built at Oak Ridge, the steam generators are located in the pit with the reactor. Maintenance is carried out by flooding the pit with water which acts as a shield, and then carrying out the maintenance remotely with long-handled tools. If the equipment must be removed, jackets freeze the heavy water in the piping to keep the light water shield out of the system.

In general, metals exposed to radiation undergo some change in their mechanical and thermal properties. For example, metals will exhibit higher thermal resistance due to radiation exposure but will increase in hardness and tensile strength. There is a reduction in percentage elongation and somewhat higher ductile-brittle transition temperature. The change in properties is less marked in cold worked materials than in annealed materials. Materials may also develop considerable internal heating due to the absorption of radiation or in collision with fission particles. The combination of heat transfer and heat generation in the materials will develop severe thermal stresses. Table 1 best summarizes some of the factors that must be considered in selecting heat exchanger materials.

Generally speaking, materials used in the reactor for heat transfer purposes must have thermal cross-sections under 1 barn in order to keep the enrichment of fuel at a low value. ("Cross-section" in nuclear engineering work is a measure of the extent to which a material will absorb neutrons. A metal with a large cross-section will absorb more neutrons than one with a small cross-section. Thus for most reactor materials we want small cross-sections so that as many neutrons as possible will be available to maintain the chain reaction. For control rods, on the other hand, we want materials that will absorb as many neutrons as possible, and so control rod materials should have high cross-sections.

The cross-section of a given material depends on the speed of the neutrons to which it is exposed. Thus, thermal cross-section means the cross-section of the material when exposed to neutrons of thermal energies, i.e. energies corresponding to ordinary temperatures. These are slow-speed neutrons. For high-speed neutrons, the cross-section will be different, usually much smaller.

(The "barn" is the unit by which cross-sections are measured.)

It is apparent then that aluminum, magnesium, and zirconium are the only materials meeting this specification. Steel can be used if a higher investment in fuel can be tolerated. With an external heat exchanger there is more latitude in the selection of materials. With the exception of aluminum and magnesium, nearly all the remaining materials have long half lives emitting gamma radiation of around 1 Mev so that the external heat exchangers must be shielded and operated remotely.

Magnesium, although it has good nuclear properties, has poor corrosion resistance to most coolants. Aluminum with good thermal conductivity is limited to below 250 C for water and 300 C for liquid metal bismuth. Costly zirconium with excellent nuclear and corrosion resistant properties is a poor thermal conductor. However, it is being used very extensively at the present time. Molybdenum appears to offer good thermal and corrosion resistant properties although its cross-section is somewhat high.

The so-called fast reactors which operate at high neutron energies are not sensitive to the material cross-sections in the reactor and therefore do not restrict their selection. These reactors are much smaller than the thermal reactors so that high heat transfer rates are very critical.

Coolants

Coolants generally used for reactors are classified as gases, waters (light or heavy), and liquid metals. An ideal coolant should be low cost and non-hazardous. It should possess good thermal properties, favorable nuclear properties such as low thermal cross-section and low induced radioactivity, non-corrosive properties to structural materials, stability under reactor conditions, minimum pumping requirements, and low melting point with low vapor pressures at

Table I. Lists some of the factors that must be considered when selecting best materials for nuclear plant heat exchangers

Material	Approx. Cost $/lb.	Thermal Cross-Section barns	Gamma Ray Mev	Half Life	Density gm/cc	Melting Point C	Thermal Conductivity Btu/hr. ft. F	Corrosion Resistance-Temp. For Following Coolants		
								H_2O	Na, K, Na-K	Bismuth
Aluminum	0.25	0.22	1.8	2.3 min	2.70	600	122	Good, 200 C	Poor	Good, 300 C
Magnesium	0.33	0.06	0.8–1.0	9.6 min	1.74	650	92	Poor	Poor	Poor
Copper	0.46	3.6	1.34	12.9 hr	8.96	1083	228	Good, Below 100 C	Good, 600 C	Poor
Stainless Steel	0.50	2.4	1.1–1.3	47 days	7.90	1400–1500	10	Good, 350 C	Good, 800 C	Good, 600 C
Nickel	0.65	4.5	0.93	2.5 hr	8.90	1455	53	Good, 350 C	Good, 800 C	Poor
Titanium	3.20	5.6	1.0	72 days	4.51	1690	100	Good, 350 C	Good, 600 C	Poor
Zirconium	10	0.18	0.92	65 days	6.50	1845	14	Good, 350 C	Good, 600 C	Poor
Molybdenum	15	2.4	0.84	67 days	10.2	2622	77	Good, 350 C	Good, 800 C	Good, 800 C

Table II. Summarizes the properties of coolants presently in use or under consideration for application in nuclear reactors

Material	Approx. Cost $/lb.	Thermal Cross-Section barns	Gamma Rays Mev	Half Life	Density 300 C gm/cc	Melting Point C	Boiling Point C	Specific Heat 300 C Btu/lb. F	Thermal Conductivity 300 C Btu/lb. ft. F	Viscosity Centipoise	Film Heat Transfer Coef. (300 C) Btu/hr. ft.$^{-2}$ F	Hazards
Helium 1 atm.	3.20	0	0	0	0.9×10^{-4}	—	Gas	1.25	0.14	0.029	20	None
Air 1 atm.	0	1.5	1.4–6	7.3 sec 1.8 hr	6.2×10^{-4}	—	Gas	0.24	0.027	0.028	20	Activity
Carbon Dioxide 1 atm.	0.08	0.003	6	7.3 sec	9.5×10^{-4}	—	Gas	0.23	0.022	0.026	25	Activity
Light Water	0	0.66	6	7.3 sec	0.800 (250 C)	0	100	1.16 (250 C)	0.36 (250 C)	0.11 (250 C)	12,000 (250 C)	Activity
Heavy Water	28	0.001	6	7.3 sec	0.880 (250 C)	3.82	101.4	1.18 (250 C)	0.36 (250 C)	0.13 (250 C)	12,600 (250 C)	Activity
Lithium	11	65	13 betas	0.83 sec	0.500	179	1317	1.0	25.4	0.43	37,000	Activity Water Reaction
Sodium	0.16	0.50	1.4–2.8	15 hr	0.88	98	883	0.31	44.7	0.35	40,000	Activity Water Reaction
Na-K 56%–44%	1.20	0.96	1.4–2.8	15 hr 12.4 hr	0.84	19	825	0.25	15.5	0.25	19,000	Activity Water Reaction
Pb-Bi 44.5%–55.5%	1.50	0.10	1.2 betas	5 Day	10.6	125	1670	0.035	6.3	1.8	18,000	Toxic

high temperatures. Needless to say, no single coolant meets all these requirements.

In the case of structural material selection there was some leeway in the choice as far as its nuclear properties are concerned since the heat exchanger may be external to the reactor. There is no such latitude in the selection of coolants, for they must pass through the reactor. Fortunately, there are a number of coolants that have low absorption cross-sections although they will become radioactive or will be unstable.

Of the gases, helium is best for it is neither radioactive nor unstable, but it is costly. Air and carbon dioxide in passing through the reactor become radioactive so that they cannot be readily exhausted to the atmosphere. There is some evidence that carbon dioxide is also unstable in a radiation field. Both heavy and light water are somewhat unstable and decompose. In the water circulating fuel system, the decomposition is even greater because of the contribution of the fission product energies. The liberated gases are recombined to prevent any accumulation of an explosive mixture and to save on costly heavy water. The alkali metals, lithium, sodium, and potassium, react violently with water and become radioactive. Although natural lithium has too large a cross-section, its isotope Li^7 has a very small cross-section and may be produced in larger quantities at low cost in the future. Lead and bismuth are very toxic and are difficult to contain.

Since heat removal is the primary function of the coolant, it must have good heat transfer properties. This criterion is even more important in the case of the solid fuel reactors in which it is necessary to keep the uranium metal below its phase change temperature of 660 C. The heat transfer property of a coolant for a fixed geometry and velocity can be measured by its density, thermal conductivity, specific heat and, in the case of non metals, by viscosity.

Table II best summarizes the properties of the coolants presently in use or under consideration. The heat transfer coefficients were determined for 250 C water and 300 C for the other coolants. Gas velocities were based on 100 ft per sec and 1 atmosphere pressure while the liquids were determined at 30 ft per sec.

The gases, based on their low densities, thermal conductivities, and viscosities all exhibit poor heat transfer coefficients. These values could be increased by operating at higher pressures, thereby improving their mass flow. However, the high pumping requirements for gases have generally ruled them out. Their most promising application to date would be in an open or closed gas turbine cycle with a nuclear reactor for stationary or aircraft propulsion. In addition, gases are not corrosive and can operate at high temperatures.

Water (heavy or light) has good heat transfer properties and low pumping power requirements. However, high temperature water is very corrosive and has a high vapor pressure, thereby requiring a high pressure system. The low boiling point of heavy and light waters prevents attainment of high overall thermal efficiencies. Heavy water, although very costly, is seriously considered because of its low thermal cross-section.

Liquid metals may be used as coolants for reactor application because of their high operating temperatures, excellent heat transfer properties, reasonably low pumping requirements, and low vapor pressures. Of all the liquid metals, sodium is probably the best, based on cost and heat transfer properties. The main drawback to sodium or NaK (eutectic of sodium and potassium) is its induced radioactivity and reaction with water. The equipment handling them must be shielded, which makes maintenance difficult. Heat exchangers for liquid alkali metal and water heat transfer must be carefully designed to prevent their reaction. Liquid metals also attack structural materials by selective solubility. This mechanism can be controlled however by additives to the coolant such as magnesium or zirconium.

Selection of coolants for fast reactors is not limited by their nuclear properties so that mercury with a high cross-section (340 barns) can be used. Organic liquids such as dowtherm can be used as reactor coolants although there is evidence of instability due to radiation.

Design

So far the discussion has been concerned with the properties of structural materials and coolants insofar as they affect selection for specific reactor application. In addition, serious consideration must be given to the precautions and equipment designs that will insure the proper performance of the heat exchangers in the nuclear power plants. Because of the hazards of radioactivity, and the thermal, mechanical and chemical properties of the materials, special techniques and designs have been developed in their application to heat exchanger design.

The fuel element in a solid fuel type reactor must be designed to facilitate the removal of the heat generated and must be able to withstand high temperature effects as thermal stresses and corrosion. The element should be inexpensive and easy to fabricate and should have good radiation stability.

Two basic designs developed to date have been the cylindrical fuel element and the plate type. In both

Table III. Summarizes principal nuclear reactor types presently being developed for power generation in this country

Reactor	Generation Heat mw	Generation Electricity mw	Approx. Plant Cost $	Fuel Element Type	Fuel Element Cladding	Coolant Type	Coolant Temp	Steam Generator Location	Steam Generator Material	Steam Generator Tube Design	Steam Generator Steam Cond.
PWR—Thermal	264	60	37.5×10^6	Plate & tubes	Zircaloy	Light Water	542 F	External	Stainless	Straight & U-tube	600 psig sat'd.
EBWR—Thermal	20	5	4.0×10^6	Plates	Zircaloy	Light Water	488 F	Internal	Zircaloy	Plates	600 psig sat'd.
SRE—Thermal	20	7.5	4.7×10^6	Rods	Stainless and Zircaloy	Sodium	960 F	External	Stainless	U-tubes	—
EBR—Fast	62.5	17.0	12.5×10^6	Pins	Stainless Steel	Sodium	900 F	External	—	Straight tube	1250 psig 850 F
HRT—Thermal	5	2.0	2.1×10^6	Circ. Fuel	None	Heavy Water	572 F	External	Stainless	U-tubes	520 psig sat'd.
LMFR—Thermal	Preliminary Stage			Circ. Fuel	None	Bismuth	1022 F	External	Cr. (2¼%) Steel	—	1250 psig 900 F

types, the elements are clad to eliminate corrosion of the fuel, stop fission fragments, cut down the danger of toxic materials getting into the coolants, and to restrain the fuel to a certain extent from warping. In order to improve heat transfer, the fuel is bonded mechanically or by liquid metal to the cladding. Thin rods or plates are desirable as they permit a smaller temperature drop in the fuel for a given power and thus decrease the thermal stresses within the element. The plate type is best for high heat transfer rates because of the effective increase in surface area. Generally, the plates are slightly curved in one direction so that they will expand in the same direction.

Fuel elements must be carefully tested to insure that the cladding has no imperfections that would permit leakage and to insure good contact of the fuel and cladding. By taking advantage of the fuel's natural radioactivity, it is possible by means of counters (scintillation and ion chamber types) to determine the continuity of the cladding material. Ultrasonic testing is also conducted on the fuel elements to insure good bonding of the fuel to cladding. Finally, by X-ray techniques it is possible to determine any flaws in the sub-assemblies of fuel elements.

Table III summarizes the principal reactor types presently being developed for power generation. Of these, only the Experimental Boiling Water Reactor (EBWR) produces steam directly in the reactor. The remainder all use external steam generators. The Pressurized Water Reactor (PWR), the Experimental Boiling Water Reactor (EBWR), the Sodium Reactor Experiment (SRE), the Experimental Breeder Reactor (EBR) are all the heterogeneous type with plate and tube fuel elements and cooled by water or sodium. The Homogeneous Reactor Test, (HRT) at Oak Ridge and the Liquid Metal Fuel Reactor (LMFR) have the fuels dissolved in the coolants with heavy water and bismuth coolants. The external steam generators are constructed of high alloy steels of the straight or U-tube design. The steam conditions of the liquid metal coolants are higher and thus give better thermal efficiencies than the water cooled type.

It is very important in steam generator design that the coolant does not leak into the steam circuit. In addition to the hazard of radiation contaminating the equipment, there is a costly loss in the case of heavy water and the possibility of chemical explosion in the case of the alkali metals. In all cases the tubes should be welded to the tube sheets. For additional protection against leakage double tube sheets should be provided with the tubes rolled to the inner sheet and welded to the outer sheet. The space between the tube sheets serves as a leak detector.

Careful inspection and testing techniques should be employed on the heat exchangers to assure their soundness. In addition to the normal inspection and test practices of penetration tests on weld passes, radiographic inspection, and hydrostatic testing, it is advisable to run mass spectrometer leak detection tests and ultrasonic inspection of the tubes and forgings.

Leak tests are based on the mass spectrometer's high sensitivity to detecting low concentrations of helium. 0.01 micron cu ft per hr of helium is usually the maximum allowable leak. The helium is admitted to one side of material to be tested, and the helium leakage is detected by mass spectrometer on the other side of the material. Ultrasonic inspection has been used where operational stress concentrations may be high. Magnetic flaw detection has also been used as in the case of HRT.

Where intermixing of fluids is not tolerable such as alkali metals and water or radioactive and non-radioactive fluids, two types of tube designs have been successfully used. In the one design, concentric tubes are used with mercury as the third fluid filling the annular space between the tubes and acting as a leak detector. In the other design, the two circulating fluids are in separate tube bundles with the tubes of the two systems adjacent to each other and in a common shell containing the third fluid for leak detection.

This latter design is called "hockey stick" and has been designed with flattened tubes to decrease the thermal resistance of the third fluid. An alternate design of recent development has been the bonded concentric tubes with suitable grooves at the bond interface to admit leak detecting helium gas.

Thermal stress problems under high temperature conditions are particularly serious in liquid metal heat exchangers. One particular design problem associated with large temperature differences is provision for differential expansion of tube and shell. The use of expansion joints or a tube design to permit deflection is normally necessary. Conventional U-tubes are satisfactory where the mean temperature difference between hot and cold legs are not too great. An alternate type would be the single pass bowed tube design. A recent design involved the use of spiral tubes.

The hazards of radioactivity may require design changes in the condensers of nuclear power plants. In the case of EBWR for example, aluminum tubes are used rather than copper. In this reactor type, the steam is generated in the reactor, passes through the turbine, is condensed, and returns to the reactor. Copper corrosion products will become highly radioactive when the condensate is circulated back to the reactor.

Aluminum has a small cross-section and a short half life so that it is preferred to copper in spite of the poorer heat transfer properties. Double tube sheets are used in the condenser with the central section evacuated to trap any leakage. All the degasifying of the condensate occurs in the condenser with an oxygen content expected to be lower than 0.01 cc per liter — a value below present condenser standards.

At this point, I would like to do some crystal ball gazing on future possibilities for the heat exchanger industry in the nuclear power field. I have been using the term "heat exchanger" rather freely to apply to the case of heat transfer from the fuel elements to the coolants in the

heterogeneous type reactors. As the present development programs unfold, certain basic fuel element designs will evolve and be used in the many reactor types.

As the demand for fuel elements increases with the increasing application of nuclear power, the fuel elements will be mass produced and sold very much like tubing for heat exchangers. Assembly problems of fuel elements in a reactor are comparable to those for tube and sheet type heat exchangers. It is conceivable that heat exchanger companies with their wealth of experience in fabrication and knowledge of heat transfer will find it profitable to design reactors. I am sure some of them have already considered this possibility.

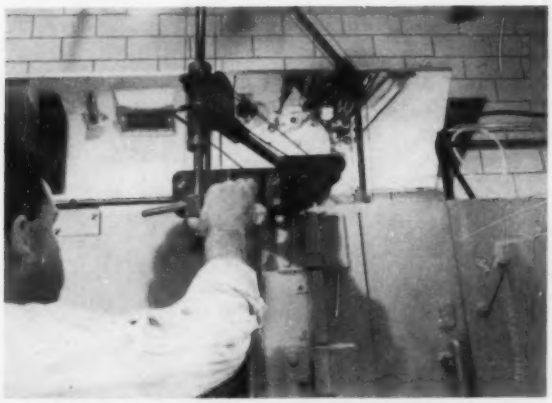
The requirement that corrosion be kept at a minimum in fluid systems exposed to radiation may produce changes in some of the present-day design concepts. The use of more corrosion resistant materials has already been mentioned. A direct result may be the elimination of deaerating heaters. The better materials will resist the slightly more corrosive water due to condenser degasification rather than high temperature deaeration. The all-welded construction of the nuclear plants and the special designs of valves and pumps to reduce air infiltration should appreciably reduce present-day air ejector capacity requirements.

Fuel elements after their removal from a reactor generate an appreciable amount of heat due to their radioactivity. At the present time, these fuel elements are allowed to cool for some 100 days before their activity has decreased to a reasonable level. In the future these fuel elements will develop into a large source of waste heat which can be harnessed say for central heating. There is then a potential market for heat exchanger design to utilize this waste heat.

I have tried to outline here the major problems connected with the application of heat exchangers in the nuclear power field. I have also indicated some of the techniques and designs presently in use for handling these problems. However, the design criteria for heat exchanger application in the nuclear field extend beyond the present standards of the manufacturers. In view of the critical nature of the many problems described, it is essential that a group such as the Heat Exchange Institute make every effort to standardize on the techniques which in their judgement would continue to insure the excellent performance record and high reliability of heat exchangers in this country.

Needless to say, a great deal of careful consideration must be given to these standards, for one serious accident involving a heat exchanger in a nuclear plant may be instrumental in appreciably slowing down the nuclear program in this country.

The above article is adapted from a Paper presented before the Heat Exchanger Institute in May 1956.



Modern radioisotope bottling unit shown above is one of many machines that have replaced the relatively crude equipment used 10 years ago at Oak Ridge National Laboratory

Radioisotopes Are Big Business

FIGURES released on the completion of Oak Ridge National Laboratory's 10th year of producing and distributing radioisotopes show the remarkable growth of what has become a new, and large phase of American industry. The Laboratory, which is operated for the Atomic Energy Commission by Union Carbide Nuclear Company, made its first shipment of a fission-produced radioisotope on Aug. 2, 1946. The shipment consisted of a small unit of Carbon-14 which went to the Barnard Free Skin and Cancer Hospital in St. Louis, Mo.

Today, over 27,000 users throughout the United States and 57 foreign countries receive radioisotopes produced at the Laboratory. In all, a total of over 85,000 units have been distributed.

Estimates of the total savings to industry alone resulting from radioisotope applications have been placed at over $200,000,000 annually. Radioisotopes are being used in radiography and radiation damage studies by industry and for many other purposes, such as "tagging" chemical compounds, mechanical-wear tests, and radiation chemistry research. Their unique characteristics have helped to open new fields in medical and biological research.

To cope with the increasing demand for radioisotopes, the Laboratory has had to expand its facilities several times during the past 10 years. From relatively crude facilities have come modern processing units capable of producing highly refined radiochemicals in quantities undreamed of 10 years ago. The illustration shows a modern bottling unit at the Laboratory.

Nearly 100 different radioisotopes are now available from the Laboratory.

Many commercial firms purchase radioisotopes in bulk quantities and reprocess them into such forms as labeled compounds, certified pharmaceuticals, and custom-manufactured radiation devices. Thus a single large unit of radioactivity from the Laboratory may represent hundreds of shipments to individual licensed customers.

"I kept all the parts, though —"

Fig. 1. General view of two drilling rigs in a core-boring operation. Sample cores, from depths determined by engineers, are analyzed by experts for character of subsoil's load-bearing ability

Investigating Subsoil for Power Plant

Character of subsoil beneath site of a proposed power plant is one of the most important items of information designers must have to build a sound structure. Here's how nature of underlying strata is found to fix load-carrying capacity

By M. ZAR*

SUPERSTRUCTURES FOR power plants are constructed of materials such as steel, concrete, and masonry, whose characteristics are well known. The substructure, however, must be designed to transfer its load to the soil, the properties of which are infinitely varied at different sites.

The most careful building designs can be nullified unless they are combined with proper knowledge of the supporting soil. Power plants, in particular, with their expensive, heavy, pulsating equipment, require careful study of founding conditions. This is necessary to avoid serious unequal settlement or failure that results in expensive repairs.[1]

In order to supply the structural designer with sufficient knowledge to prepare foundation designs that are adequate, yet economical, subsoil exploration is necessary. Generally, the cost of the investigation will be much less than the savings achieved by economical design or the cost of failures that are avoided.

Unsatisfactory Methods

There are few fields of engineering in which there is more danger of jumping to false conclusions than in the field of subsoil exploration. Here are some methods of soil investigation, which, although adequate for lesser structures, usually furnish incomplete or erroneous information for heavy buildings such as power plants. For example:

Test pits give very accurate information of the soil exposed, but no indication of the lower strata to which the loads are ultimately transferred.

Subsoil characteristics vary so greatly, often over a very small area, that assumptions made from a test pit, about conditions below the pit, can often be very misleading.

Driving an open pipe will not recover an undisturbed sample.

Well drilling with the use of a slurry completely destroys the natural state of the soil.

Wash boring samples are completely unrepresentative of the undisturbed soil since they come from sediment deposited by water in washing out a hole.

Proper Method

In lieu of the above, a specification for obtaining undisturbed samples should be prepared and a competent soil boring contractor should be selected — one who has capable personnel for providing intelligent and accurate reports, and who possesses proper equipment to carry on the work.

The contractor should work from a drawing, prepared by the engineers, which locates each boring and indicates the depth to which it should be taken. Usually the boring foreman is required to mail daily field records to the engineers to enable the designers to plan the foundations early and to vary the program of bore sampling, if the daily reports should warrant it.

In order to permit the engineers complete flexibility in adjusting the boring depths and locations as the daily reports are received, the contract for the drilling should always be on a unit price basis with units per foot for drilling each type of boring anticipated.

Most boring methods utilize water under pressure for sinking the holes between sample points. A 2 or 2½-in. casing is driven into the ground and the soil in the casing is washed out to a point below the bottom of the casing. The washing pipe is then removed and a standard split-spoon sampler, 2-in. outside diam and at least 18-in. long, is placed in the bottom of the hole and driven for a distance of 12 in. by a 140-lb weight falling a distance of 30 in.

A record of the number of blows required to drive the sampler 12 in. should be included in the daily report. This information is of value in determining the relative density of sand or the consistency of clays. The sampler is then removed from the hole and an undisturbed portion of soil is taken from the spoon and

[1] See "How Subsoil Affects Your Power Plant Foundation," POWER ENGINEERING, June 1956.

*Associate, Sargent & Lundy, Engineers, Chicago, Ill.

Fig. 2. Operator opens spoon to extract sample core. Undisturbed sample is transferred to jar

Fig. 3. Subsoil samples from core-borings are placed in tightly-stoppered jars with hole number, penetration record, other data

Foundations

placed in a bottle with a tight screw top and labeled with the following notation:

1. Hole number
2. Penetration record (described above)
3. Date
4. Depth of sample
5. Description of material

Sample Spacing

One sample should be taken each time the wash water indicates a change in soil, but in no case should the samples be taken further than 5 ft apart. The ground water level should be determined and any peculiar water conditions noted as the hole is being made.

Undisturbed samples for laboratory testing of plastic soils can be obtained by means of a Shelby Tube, which is a 2-in. diam, seamless, thin-wall tubing of 16 to 20 gage thickness. It has a beveled cutting edge to permit the tube to be forced rather than driven into the soil. As soon as the tube is pulled, it is sealed with paraffin, and after it is labeled it is sent to the laboratory for analysis and testing.

Drilling in Rock

If the driller encounters rock before reaching the required depth of the hole, then the rock should be cored with a diamond drill for about 10 ft. The report should include the percentage of rock recovery. It is also important to record the time required to drill each rock sample and the loss of wash water. The cores should be placed sequentially in a wood box for ready identification afterwards.

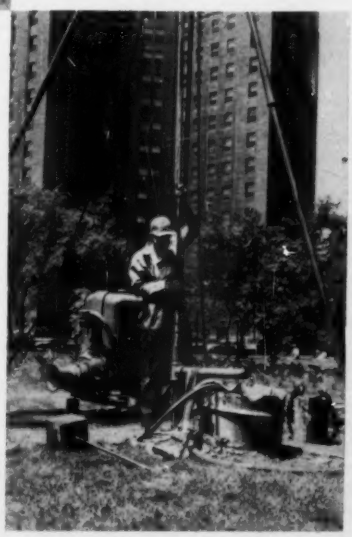
Upon completion of the drilling, the contractor should be required to submit to the engineers a report which includes a sketch indicating the actual location of each boring. The report should also contain a summary of all the data submitted in the daily reports, and, in addition, complete descriptions of unusual conditions such as sudden increase or decrease in penetration of the split spoon, squeezing or caving-in of the walls of the bore, loss or influx of water, difficulty in recovering rock cores from the drilling, etc.

The engineers should obtain sufficient field data from the described procedure to prepare substrata profiles of the power plant site and determine from them the proper depth at which to place the foundations and the type of foundation design required.

Photos courtesy KOF Foundation Test Borings, Inc.

Fig. 4. (*Left*) Washing out hole preparatory to driving sample spoon into subsoil at depth previously selected by engineers; this gives clean sample

Fig. 5. (*Below*) Disconnecting wash pipe. Pump is driven by 2½-hp, 1 cyl gas engine. Main drilling rig is powered by 20-hp gas engine with winch



Don't Build Problems Into Your New

Time to solve operating problems is *before* new plant is complete. Writing from experience, author shows how forethought may avert cost, annoyance of minor troubles

By PAUL N. GARAY

SO, YOU ARE PLANNING or building a new plant, and you anticipate a vacation from the troubles that have hounded you? Well, it won't be so easy, because the first program your chief will initiate will be a series of changes designed to bring the new installation to a point where operations will be as his technical competence and manpower requirements dictate.

Some changes may be in the nature of corrections to design or construction faults; some may be in the nature of improvements to permit better or easier operation, cheaper maintenance, convenience, or greater safety. In any event, money will be expended.

This is not, however, a mandatory state of affairs. Large power companies avoid such a state by maintaining extremely close surveillance over the design and construction phases of their operations. The majority of small plant owners, however, may find such exact control to be impossible due to lack of technically qualified critics. Their operators may be fine, capable men, but are frequently not qualified to argue with design engineers over designs on paper. And certainly it seems that designers rarely consult with operators on installation points which may affect maintenance or convenience.

Here, then, are a number of suggestions which, considered in connection with your own present or proposed operations, may solve or obviate a number of the small but persistently annoying problems that need not be included in the plant. The discussion does not propose to present absolute cures or magic formulas, but does attempt to offer several thought-evoking comments pertinent to plant betterment at the cheapest level — the planning and building stages.

Many of these comments were drawn from actual experience with our 240,000-lb per hr, 250-psi plant, which is small enough to parallel the conditions faced by most small plant operators, but, at the same time, is of sufficient size to be subject to difficulties common to the entire steam plant field.

Our critique will generally embrace one or more of the factors of design, construction, or maintenance. These divisions are somewhat arbitrary, since they are so largely interacting. However, I believe such classification will generally expedite recognition of the problems to be encountered.

Prior to any approval of planning or equipment, a few generalities should be considered regarding points which will affect construction and operation of your plant. It is a trite but true expression that "you get what you pay for." Except that in some cases, by using common sense, you can get more! For your purpose, the most expensive is not always the ideal. Consider a sump pump which may be used but rarely; it obviously can be a cheaper type of pump than the boiler feed standby pump, which must not fail in an emergency.

Categorize your equipment as indispensable, very desirable, and desirable, then ask yourself these questions: "What happens if this component fails? Can it be fixed by the grade of mechanic I have available? Will I need special tools or special parts? How quickly can the unit be put back on the line?"

Most Units Dependable

Most units on the market today are dependable. We must give consideration to how good they will be 5, 10, or 20 years from now. All manufacturers will sell you bearings, packings, seals and other components from their stock, usually with some delay for delivery. Most of the bearings and packings can also be ordered direct from the bearing or packing manufacturers at a saving in time and money. The parts will be equal of the original item. The units under consideration should have minimum requirements for specially manufactured parts. A large and expensive spare parts stock is to be avoided. Check the availability of parts.

Check, too, the source of local supplies. Avoid dealing with a distributor who must refer everything to a home office, or you will certainly be disappointed in the service you get from him. Check the availability of service facilities; will you receive promps visits from the service engineer, at no per diem cost, or have to wait for his monthly visit?

Will the distributor show some interest in the installation and use of the unit, or does his responsibility end with the delivery of the product?

During installation, remember that a contractor, however reliable, has various grades of workmen in his employ. You must insist on cleanliness in all your completed systems. The prime source of all your troubles for the first year will be due to foreign materials in the system. Use vacuum cleaning to pick up loose dirt; blow out completed lines in both directions; flush with water.

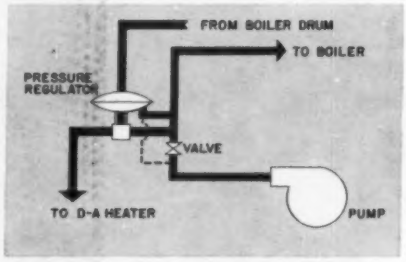


Fig. 1. Original oil pressure regulating system; dotted line is improvement

Piping should be supported firmly, with expansion being taken care of by proper placing of supports or by expansion joints. A loose pipe will become a leaky pipe. Don't be fooled by the story that a loosely hung pipe is necessary for expansion. The only allowed motion should be longitudinal.

Large flanges, valves, traps, and other units should be aligned so no stresses are set up when the joints are tightened. Machinery couplings should be aligned by instruments. Don't trust the mechanic who insists that he can do a better job with his hands than with gages. He is either lazy or incompetent or both. Have the contractor promise to return in 3 to 6 months to re-align and permanently pin all machinery units. An over-all guarantee will not always accomplish this.

As a last generality, don't be misled by the "something for nothing" salesman. Water treatment, for instance, is based on fairly complex but well defined principles; don't buy a "gimmick" that is guaranteed to do away with all your water treatment problems. Analyze your salesman's logic carefully. If in doubt, get several opinions on similar units.

Having noted some of the considerations essential to proper planning and construction, let us now consider some of the design faults which are common to small and medium plant designs. A list of our plant equipment will clarify the type of plant we are using as an example.

Boilers: two identical, water tube, 140,000-lb per hr, at 250 psi, saturated; oil fired, steam atomizing, variable-capacity burners.

Pumps: one 500-gpm and one 300-gpm turbine-driven centrifugal boiler feed pump; one 60-gpm electric-drive centrifugal boiler feed pump; three centrifugal condensate transfer

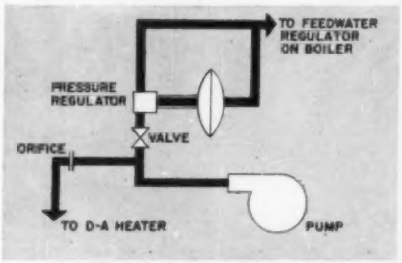


Fig. 2. Way of regulating pump output by adjustment to suit pump and system

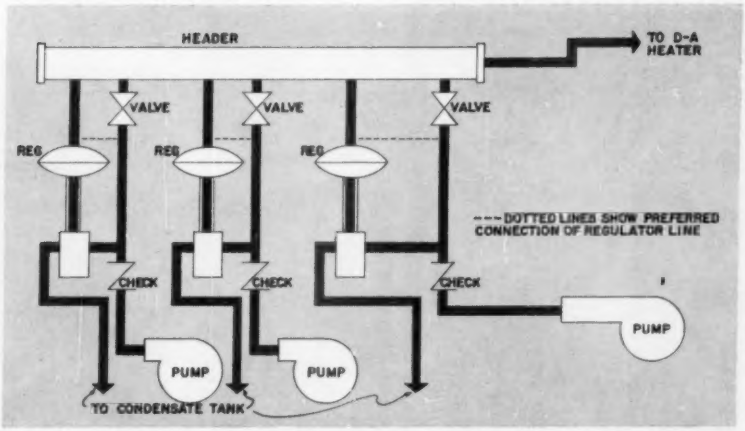


Fig. 3. With control lines connected to header, regulator valves are operated by pressure in common header, instead of varying according to pump requirements

pumps, electric drive, of 500-, 300-, and 150-gpm capacity.

Fuel oil pump: two electric-drive, screw-type, 50-gpm circulating oil pumps; one 25-gpm and one 50-gpm oil burner feed pump.

Air compressors: electric drive, 2 large, 2 small.

Blowers: two 50-hp, forced-draft electric drive; two 130-hp turbine drive induced draft blowers with belted 30-hp electric drive.

Water softener: dual 300-gpm unit.

Auxiliaries include fuel oil heaters and deaerating feed heater.

Perhaps the most common design error is the assumption of a certain operating range with inadequate provision for accomplishing this condition. A range of possibly 5 to 1 from high to low presents no difficulties. In our case, our expected range was on the order of 10 to 1. Difficulties in control were introduced, since a sensing element with linear response at full load will operate on a very critical curve at $\frac{1}{10}$ load. Regulating valves operate in an almost closed position, and pressure drops throughout the system become excessive. Metering becomes difficult since errors are magnified at the low end.

The solution? Well, it is difficult to correct such a situation, but the problem can be minimized by the use of dual-range elements in the system. This is not as difficult as it sounds. Meter ranges can be varied by using different sized orifices. Regulators of two sizes may be used in parallel for high or low loads. Pressure in various parts of the system can be controlled to provide acceptable pressure drops through control elements. Controls can be made dual-range by provision for increasing sensitivity for low range operations.

Our feedwater and condensate pumps presented no problem, since we had a choice of 3 sizes in each case. Anyhow, in the case of a centrifugal pump, horsepower is in proportion to delivery, so normally we pay only for the delivery used.

This, however, was not true of our fuel-oil pumps, which are of the positive displacement screw type. Here the excess capacity was relieved by pressure relief valves, and horsepower used was always fairly constant. In the course of a few years of operation, this power waste would pay for, 1, a dual-speed drive, 2, a continuously-variable speed drive, 3, a special low-volume pump, or 4, a continuously variable-volume pump.

Fuel-Oil Heaters Oversized

Fuel-oil heaters in many plants are oversized. The usual sizing is 100 per cent and 50 per cent. A better distribution of capacity would be 65 per cent and 35 per cent.

As stated before, feed-pump capacities presented no problem, but pressure regulation using the constant speed electric-drive feed pump was faulty due to, 1, pump not running on the specified curve, and 2, faulty design. At low loads the pump would push 380 psi, in contrast to the design pressure of 330 psi, and since the boiler pressure was normally 250 psi, the excess pressure drop across the boiler feedwater regulator not only caused erratic operation, but excess wear on the valve. The pressure regulating system (Fig. 1) was designed to regulate pressure by bypassing excess pressure. This system is impractical due to the characteristics of a centrifugal pump.

In our case, an estimated 90 gpm was passing through the pump bypass alone, plus that amount going to the boiler. Since the pump was rated at 60 gpm, the motor was seriously overloaded. The dotted line of Fig. 1 shows a better way to connect the pilot line. In this improvement, we can control our output somewhat by throttling the discharge valve, and in the event that the valve is entirely closed, the regulator will still relieve the pump. Figure 2 shows a way of regulating the pump output which can be adjusted to suit the operating characteristics of pump and system. A considerable power saving accrues.

A regulator problem also existed in the setup of our 3 condensate pumps. Normally, we ran with the discharge valves open, for easy changes. The check valve prevents any reverse circulation. However, unless the pressures were exactly matched, the pump with the lower pressure ceased delivering, and overheated. The hookup also prevented the regulator valve from relieving the pump if the discharge happened to be closed.

The regulators were of the diaphragm-actuated type, with all the control lines connected to a common header (Fig. 3). The net result here was that the regulator valve operated not according to the pump requirements, but to the header pressures.

Furthermore, unless each pump was shut off from the line, only the regulator with the lowest pressure setting would operate. As originally connected, it would have been better to use 1 regulator instead of 3 to control delivery, and provide each pump with an orifice bypass for protection (Fig. 4).

This system is again a method of controlling delivery similar to that applied to the electric-drive feedwater pump. However, in this case the design works better since the variation occurs over a much smaller section of the pump curve. The dotted line of Fig. 3 again shows where the regulator control line should have been to relieve the pump in case of a shutoff.

Yes, pumps can be and have been operated in parallel satisfactorily. However, the individual operating curves must be selected properly to give stable operation and to divide the load correctly; then the pumps must be matched to these curves and maintained that way. These are, however, difficult adjustments for the average small plant operation.

Another pump problem was in connection with our turbine-type condensate return pumps situated in the field. These pumps have characteristics of a positive displacement pump, with horsepower varying according

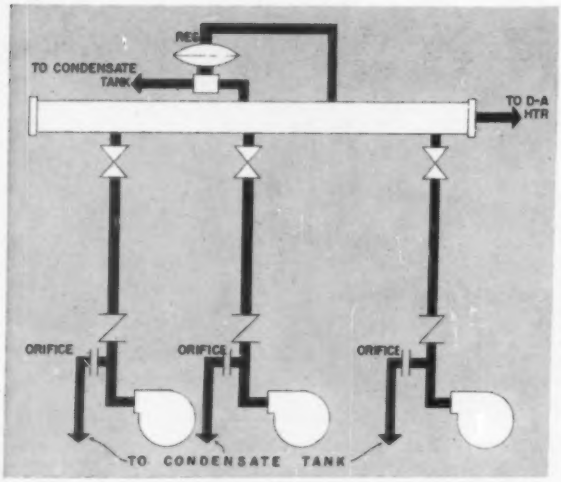


Fig. 4. Alternate method of controlling delivery; only one regulator is used, each pump has bypass orifice protection

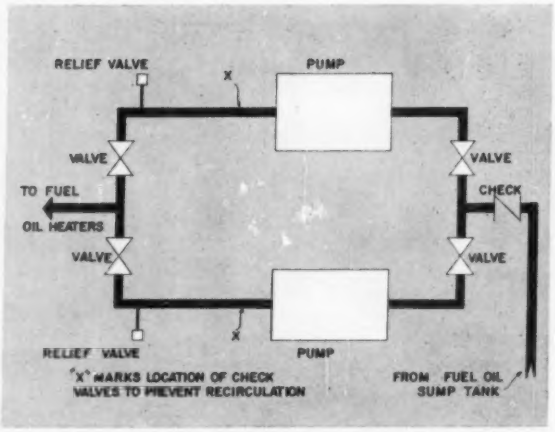


Fig. 5. Fuel-oil pressure pump connections; opening valves on idle pump caused local flow. Correction: valves at "X"

to the pressure. An attempt was made to control delivery of these pumps — the horsepower rose as the discharge valve was closed, resulting in blown motor fuses.

These pumps should have been provided with pressure relief valves to prevent motor overloads. The correct way to control delivery would have been with a valved bypass from the discharge back to the suction.

External Packing Helped

Let us again return to our fuel-oil heater set for some additional comments. The fuel-oil pump originally specified used an internal seal. The seal broke down and flooded the gear case, with a consequent breakdown of the gears. After 3 failures, the 4th replacement was the same type pump with an external packing, after which no further repairs were needed. The presumption here is that for this type of hot oil service (130 F), internal seals are inadequate. This point will no doubt be vigorously contested, but such has been our experience.

Figure 5 shows a circuit between our two fuel-oil pressure pumps such that when the valves on the idle pump were opened, preparatory to putting it on the line, a local circulation occurred which robbed the burner feed line of its pressure and put out the fires. It was necessary to shut down to change pumps. Installation of check valves at X, Fig. 5, solved this problem quite simply.

An annoying problem in connection with the fuel-oil circuit was the location of the excess capacity relief valve, which was located so that any oil relieved from the system was passed back to the tanks at a temperature of close to 200 F. The oil storage tanks would frequently attain a temperature of 180 F.

The problem was solved quite simply by replacing the original small pressure relief valves with larger adjustable relief valves. These valves could be adjusted to maintain any desired system pressure, and bypassed the oil before it was heated. (Fig. 6).

In connection with fuel-oil tank heat requirements, we have found in a year and a half of operation that no tank heat was required after our initial start-up. Our storage is 100,000 gal in 4 25,000 gal tanks, and our usage varies from 2000 to 10,000 gal per day. In the face of these conditions, we have all the heat we need from the fuel oil, which is delivered at 140 F. If more heat should be needed, we can crack the burner line recirculating bypass to warm our tanks. We realize now that, except for one tank, tank heaters could have been eliminated entirely, and this one heater could have been manually valved. Savings incident to eliminating temperature and pressure regulators would have been considerable.

Should cold starting become frequent enough to present a problem, Fig. 7 shows how we can utilize our installed fuel-oil circulating pump to use diesel oil directly, bypassing the sump tank, heaters, and burner manifold. The additional system would require only the installation of a suitably sized tank for diesel oil. Although this pump normally operates at low pressures, it will operate at 100 psi with adequate capacity to one or two cold atomizers.

Consideration of equipment duplication involves problems that must be considered on their own merits. For instance, many plants will have a set of air compressors for the boiler controls, a set for heating system pneumatics, a set for plant service, and finally, a set for soot blowing.

The design could be engineered to use but one set of air compressors, with the attendant reduction in first cost and maintenance. Should a large quantity of air be required for short periods, as in soot blowing, a separate volume tank can be installed to prevent pulling down the system pressure.

In our plant, controls for the heating-system used air at 5 psi from a 75-psi tank. Controls for the boiler system used air at 25 to 40 psi from a 100-psi tank. These systems were cross-connected, and now only one set of compressors is in use.

The same line of reasoning holds true for steam systems. Our plant had separate reducers for atomizing steam, for de-aerating heater steam supply, for fuel-oil heaters for tank heating, and for steam lancing service. Since all these services operated at roughly the same pressures, these several reducers could economically have been replaced by 2, in parallel, sized at 100 per cent and 50 per cent of load. Increased savings would have resulted from elimination of additional high pressure valves and piping.

Separate Systems Valuable

When considering maintenance costs as a factor in plant design, thought should be given to separate systems so that in case of a shutdown of any component, a minimum number of systems would be out. Our feedwater line was branched to feed two boilers; consequently, any work on the feed line at one boiler required shutting down the whole feed system, since there were no branch valves.

Similarly, the pump-turbine steam and the atomizing steam came through the same header valve, with the result that work on the turbine throttle valve required shutting down the atomizing steam also. This valve, by the way, was a 4-in., high-pressure, screwed-in valve, and the only way to replace it was to cut the line and weld in new flanges—an expensive procedure.

Much literature is available concerning the correct use of valves, and yet, in too many installations, valve selections and placement are left to the pipefitter or boilermaker who is unfamiliar with the requirements.

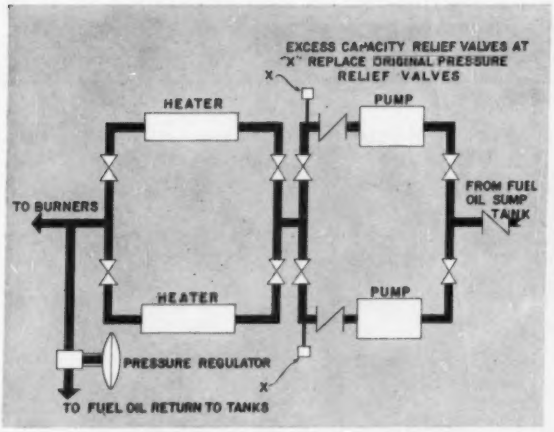


Fig. 6. Fuel-oil heater circuit shows how addition of larger adjustable relief valves at points "X" cured hot oil problem

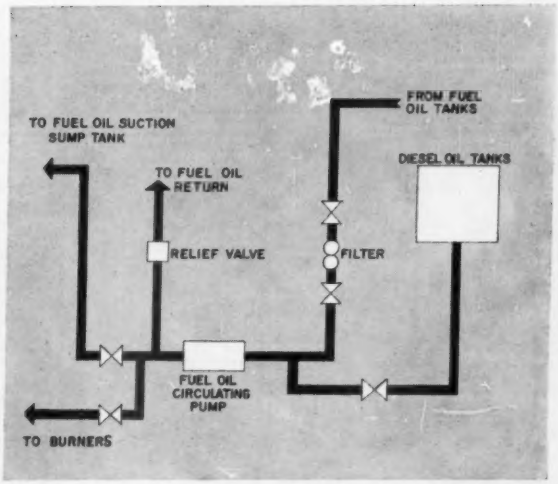


Fig. 7. Method of arranging existing fuel oil circulating pump circuit to handle diesel oil by addition of tank only

Our installation specified a great many gate valves, which proved to be a continuous source of trouble.

As a general rule, gate valves should be specified only where maximum flow and infrequent operation is desired. A gate valve is hard to keep tight, is hard to repair, and will quickly be wiredrawn and damaged if throttled.

Globe valves are far superior for most services, and they have the additional advantage of being available in construction suitable for throttling service. For economical maintenance, valves should be specified which have replaceable seats as well as discs. The hardened-plug type valves with an elongated seat should be specified for severe service. These latter will prove to be trouble-free and long-lived; they should be mandatory on bypass lines, for soot blower stops, throttle valves, and hot-oil throttling valves on burners.

It is realized that globe valves present a much greater resistance to flow than a fully-opened gate valve, but this objection can be minimized by proper sizing of valves, use of angle valves, or use of Y-type valves. In controlling water flow, of course, gate valves may be preferable, since leakage presents less of a problem and the valves would not be so subject to cutting as is the case with steam.

All the large valve companies issue booklets with recommendations for proper selection and installation of valves. Read these; they will help to eliminate a potential maintenance sore spot. General requirements are:

1. The valve should *fail safe*
2. Pressure should tend to close the valve
3. Pressure should not be on the packing

For minimum pressure drop, angle valves should be specified. Lines 3 in. and larger should be fitted with equalizing or warming bypasses; this is also necessary on turbine pump and soot blower valves. Although I have not seen bypass lines orificed on the low pressure side of a valve, it would seem that such a device would reduce the steam velocity where a pressure differential of 0 to 250 psi may exist, as in a warm-up or bypass valve. The valve life would be thus extended at no extra cost.

Placement of Stems Important

Valve stems should be up, or horizontal; should they be down, sediment will collect at the bottom, and ruin the packing. Catwalks which are provided for high-up valves or headers should be close enough to permit packing replacement without forcing the mechanic to hang over space. Valves which are meant to be operated from the floor should be within reach of man of normal height or should be provided with chains or reach rods. In our plant, yokes and reach rods were standard nuisances, but necessary.

We were also provided with swing check valves in low pressure lines. Being installed horizontally, they would keep up a continuous slapping 50 times a minute — a condition which is not conducive to long life. These valves might better have been installed vertically, or spring checks should have been used. A globe-type check is, moreover, better in that it can be made tight more easily than a swing, by just removing the cap.

In some portions of our plant we were subject to severe water hammer. One of our worst locations was in a 3-in.-high pressure trap drain which came into the plant through the cellar, and discharged into the deaerating heater 40 ft above. Since there was no separation of steam and water, a severe knock was persistent, threatening to break loose all the pipe joints. Tnis is common where steam is required to push water uphill.

The problem was quite simply solved by using a large trap to drain the line into the condensate line. Should the amount of water have been large, we could have used a flash tank with a float valve to maintain water level.

Standard procedure should be to include drains at the low point of any steam line, or hot-water line which may carry some steam.

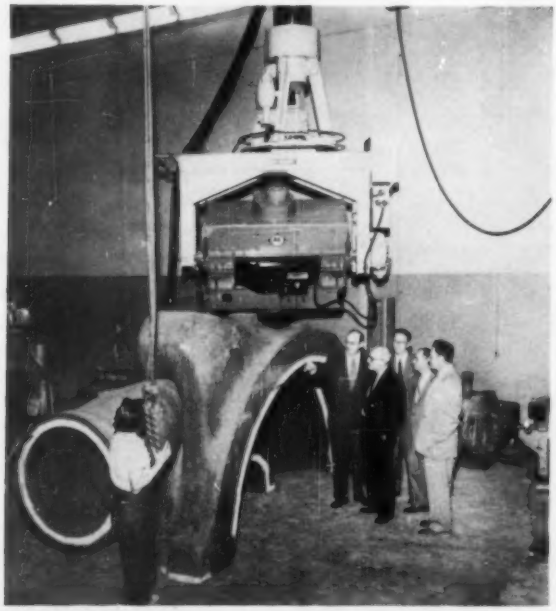
When considering the cost of our boiler operations, it is known by many examples that internals can be kept perfectly clean by proper water treatments. However, for these treatment methods, the old "one shot" methods of application are no longer adequate. Although treatment can be easy, proper equipment is required.

Provision should be made for chemical feed into both the drum and into the feedwater tank. The ever present problem of CO_2 corrosion in the condensate return lines can be solved by using a 3rd pump to introduce an amine compound directly into the steam header, or steam main. We installed a small-volume duplex pump, and a similarly designed simplex pump to treat our system. After 1½ years of operation, our boilers do not even need wire-brushing.

As a final design requirement, don't omit your safety devices. Our plant was designed to be operated with 1 man per shift, so we didn't feel easy until several safety devices were installed. Low water cut-offs, of course, were mandatory.

In addition, we installed a system of relays to sound a loud alarm horn in case any of the following conditions occurred: Low or high steam pressure; low or high water; loss of feedwater pressure; low water in condensate tank; low water in deaerating heater storage tank. Thus, wherever the operating engineer may be, his attention will be called whenever these conditions occur, and in time to take the necessary corrective steps. The hookup was simple, and we now feel much more secure.

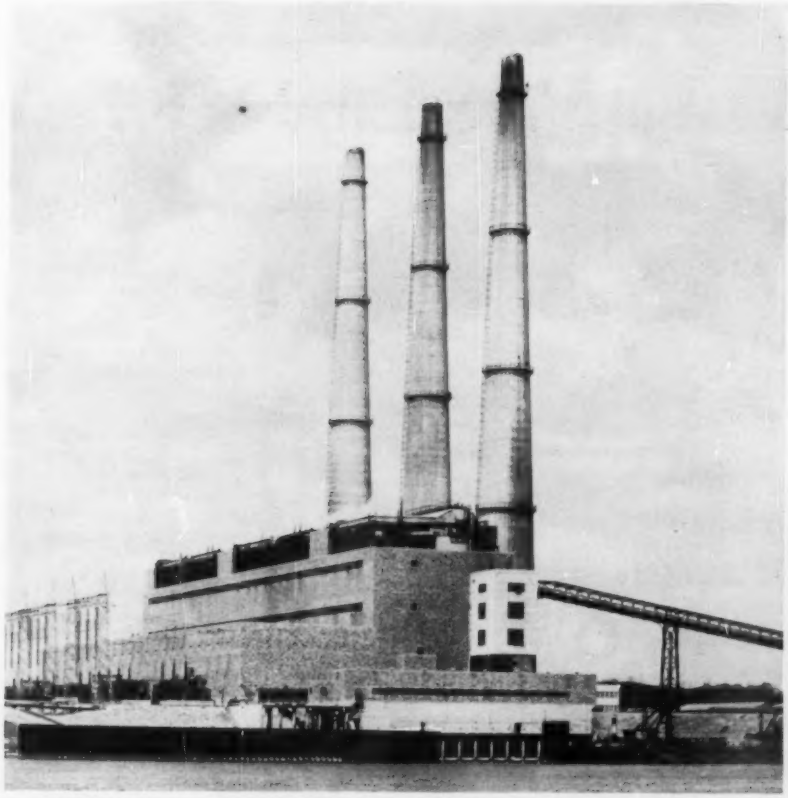
POWER ENGINEERING'S *NEWS REEL*



22,000,000-volt betatron makes radiographic test of steel casting; this inlet reaction element was built at Allis-Chalmers as part of one of two 1800-rpm low-pressure turbines for Commonwealth Edison's 300,000-kw Fisk Station

Reactor safety is ensured by tests (top) of reaction of sodium and potassium with water. Thermocouples (bottom) are installed in reactor boiler tubes to measure precise heat of molten metals. Tests, devices are all part of Detroit Edison's atomic power program

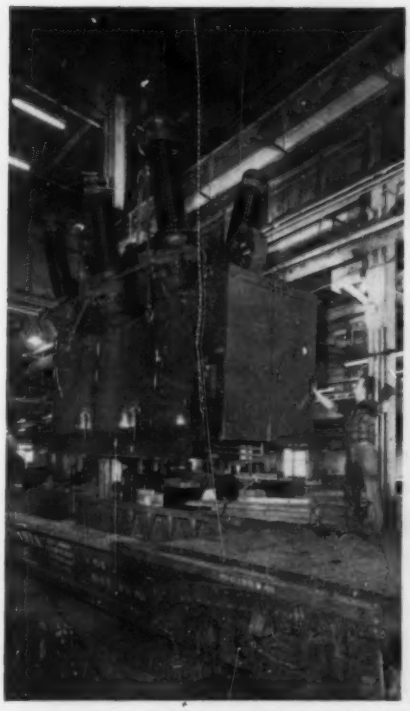
Natural gas pipeline in Pacific Northwest is tough row to hoe, but big International crawler tractors help make job possible. Here, two tractors act as anchors for welding truck lowered down grade to pipe welding juncture. When completed, this 1487-mile line will pipe natural gas from Colorado to Washington State

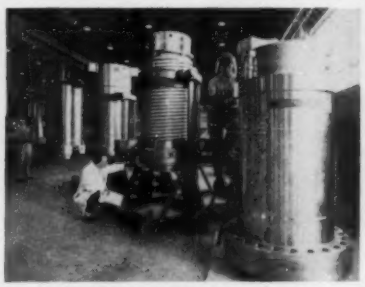


Kyger Creek station of Ohio Valley Electric Corp., Cheshire, Ohio, is giant partner of Clifty Creek plant at Madison, Indiana. Together, these two power plants provide a total capability of 2,365,000 kw to meet needs of AEC uranium diffusion center nearby. Five units at Kyger Creek generate 1,075,000 kw

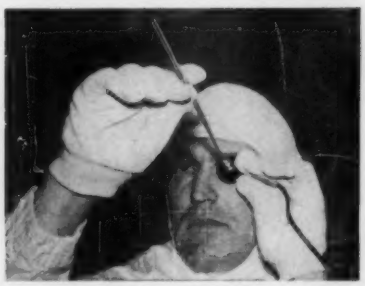
Largest and heaviest hydraulic turbine runners ever cast in U. S. are used at Garrison Dam. Baldwin-Lima-Hamilton supplied this and two others

Oath of office is taken by Harry Kuljian, widely-known engineer, when sworn in as new Board of Health member by Philadelphia's Mayor R. Dillworth





World's biggest canned pumps, near completion at Westinghouse, are readied for delivery to nation's first full-scale atomic plant, Shippingport, Pa.



Sneaky Peeky is what the GE boys at Hanford Atomic Plant call it. It's actually a doctor's cystoscope, used at Hanford to see where they couldn't

First dead-tank high-capacity outdoor compressed-air circuit breaker ever built is shipped to Consolidated Edison Company of New York; this is first of 21 identical units to be delivered during late 1956, 1957, and 1958. Developed by Westinghouse, the 138-kva units have normal current rating of 1600 amp and an interrupted rating of 10,000,000 kva. Air pressure is approximately 250 psi

Transformer Test

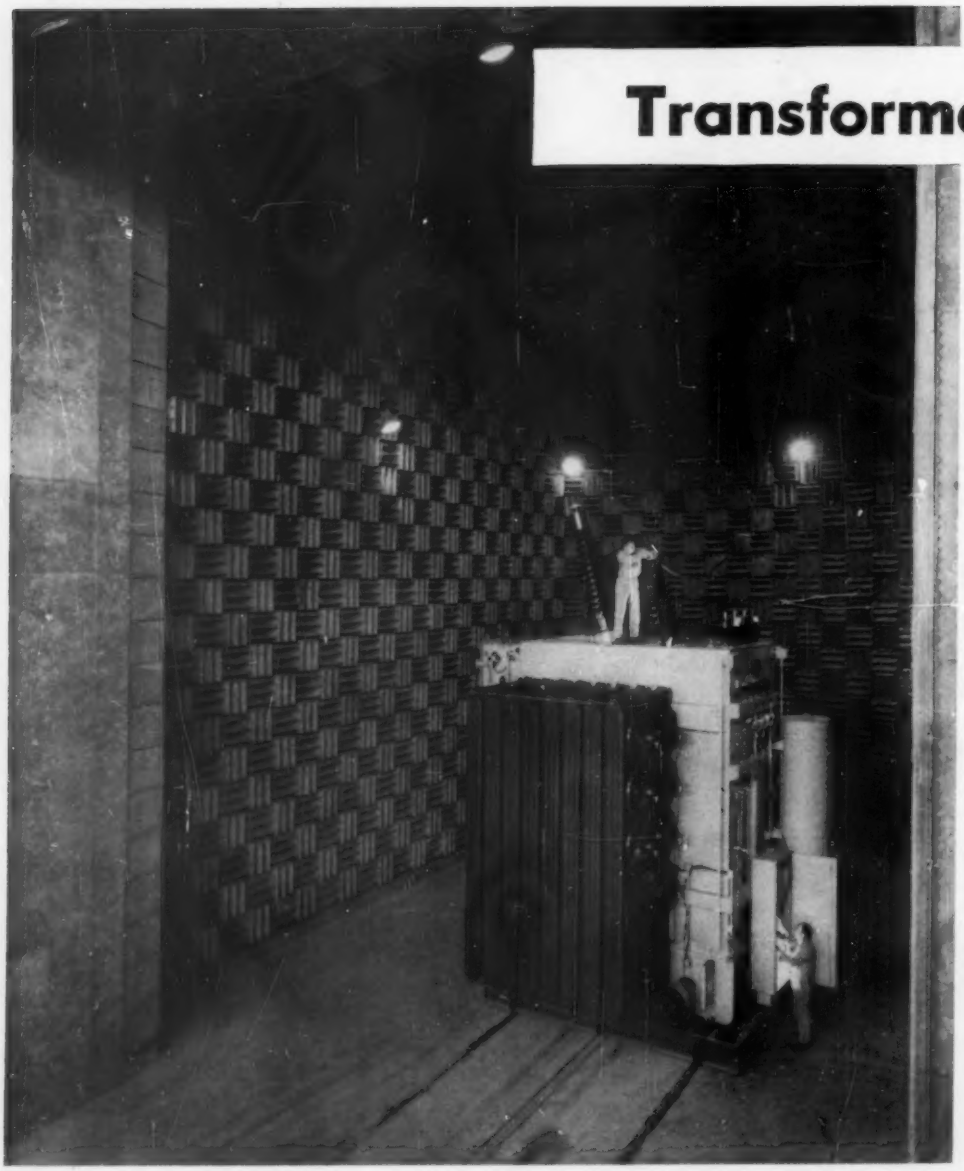


Fig. 1. Above. Transformer being prepared for test in anechoic vault. Each wall has 12 in. concrete, layer of galvanized steel, a 2 in. blanket of fiber glass in a 9 in. air space, and a lining of 3 ft thick fiber glass wedges

Fig. 2. Right. View through observation window showing the IBM 705 computer used for transformer design as well as for general data processing. In background are magnetic tape units for information storage

Center Shows Interesting Trends

WHEN THE WESTINGHOUSE Electric Corp's new transformer test center was recently put into operation, in addition to the mass of new equipment that represented an improvement of size and efficiency over existing test facilities, one or two items were especially significant for their value in showing certain trends in transformer manufacture and operation.

For example, the large and expensive equipment installed for the testing of transformer noise levels reflected the increasing public concern with the problem of noise in electrical machinery. Figure 1 shows the large soundproof bay, called an anechoic (without echo) vault, built to absorb internal sounds, exclude external sounds, and to shield against radio interference voltage. The fact that the vault cost $3,500,000 emphasizes the importance attached to noise reduction in modern transformer design.

The anechoic vault is actually a large reinforced-concrete and steel box structure, approximately 70 ft long by 55 ft wide by 60 ft high. The concrete walls are a minimum of 1 ft thick. The inner walls are structurally separated from the outer ones, except for a minimum number of resilient ties needed for lateral support. The whole vault is structurally separated from the main building to reduce transmitted vibration.

Inside surfaces of the walls, ceiling and large door are covered with a lining which absorbs internal noises. This anechoic lining consists of fiber glass wedges three feet thick. This wedge construction, designed to absorb at least 99 per cent of noise at frequencies of 100 cycles per sec or greater, is encased in ½ in. mesh hardware cloth to provide the necessary structural strength.

In addition to the requirements for sound insulation, the anechoic vault has metal shielding that allows radio influence testing of equipment without being affected by outside sources of radio influence voltage.

The vault can accommodate transformers rated more than 500,000 kva and weighing more than 400 tons. Although commercial tests will be made in the vault, it will be used primarily as a research and development tool to aid in improving future transformer design. It is designed for an ambient noise level of less than 30 decibels — a sound level comparable to that of a quiet suburban residence.

Another interesting development in connection with the new transformer facility is the use of an electronic computer to speed up transformer design. The machine being used is an IBM-705, a general data digital computer. Though this machine needs more laborious setting up than an engineering type of computer, it has the considerable advantage that the information comes out in a form that can be used immediately.

Design values, such as number of turns, thickness of insulation, quantities of cooling oil, etc., come out as printed figures, to be used directly. The machine even turns out a diagram of the most efficient arrangement of fans and coolers for a given design. With the engineering type, the information given out by the machine has first to be decoded before it can be used.

Setting up the machine is slow and laborious, but once this has been done, then, by just putting in five punched cards bearing all the necessary design requirements, the machine turns out the complete design in less than 5 min.

Product lines at the Sharon plant range from specialty transformers, weighing less than ½ oz, to large power transformers weighing more than 600,000 lb. In their approach to this data processing problem, the company chose from this range a style most readily adaptable to solution on the machine. The selected type was a core form power transformer, oil immersed, with ratings from 1000 kva to 15,000 kva and voltage classes up to 69 kv.

In setting up a program of this type data is prepared which would, in effect, allow solution by an engineer of any design problem in this area of core form transformers. However, an engineer requires about 3 days to produce the electrical, mechanical, and thermal specifications necessary for production of the drawings and other information that would permit a shop to produce the unit.

The 705 computer, however, requires only from 3 to 6 min to produce the same electrical, mechanical, and thermal specifications. The program is set up at present for the production of some 2000 standard designs of this transformer. In addition to all the specifications, the machine produces a plan view of tank outline showing the best arrangement and size of cooling radiators.

Here are a few examples of the speed and capacity of this computer. From magnetic tape, the machine can accept data at the rate of 900,000 characters per min; from punched cards, 20,000 characters per min. Processed data can be recorded by the output unit at the rate of 900,000 characters per min on tape, 8000 characters on punched cards per min or 150 lines of printed information, i.e., the equivalent of 18,000 characters per min on the printer.

In 1 second, the central processing unit of the computer can perform 8,400 5 digit additions or subtractions, 1250 multiplications (5 digits by 5 digits), 550 divisions (6 digits divided by 4 digits) or make 29,400 logical decisions. Its magnetic core memory can store 20,000 characters at the rate of 58,800 characters per sec. The magnetic drum can store 60,000 characters at the rate of 25,000 characters per sec. The magnetic core memory can recall at random any stored data at the rate of 17 microseconds per character.

Since no one operation at Sharon could support the cost of a computer, it was necessary to use the machine for a wide range of business and scientific procedures. To start with, the machine is being used for payroll accounting, inventory control, the issuance of manufacturing information to the shop, and engineering design calculations. As experience is gained in its use, it will be applied to other operations as well.

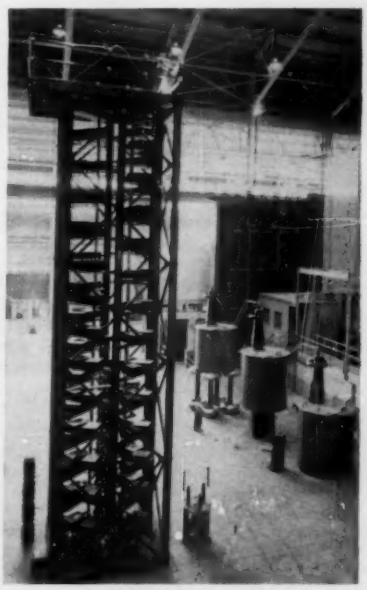


Fig. 3. 50-ft high, 5,200,000-v surge voltage generator, part of development area in the new $13,000,000 test center

Energy for Tomorrow—Inventory

HISTORIANS seeking a name to designate our era have called it the Machine Age. Actually, it is not in the use of machines as such that our civilization differs from mankind's previous experience. It is rather in our use of heat engines to supply energy for the running of machines which are in many cases modern versions of early ideas. The Greeks, Romans, Moors and Persians used pumps, hoists, and mills, but their only sources of energy were water, wind, and the weary muscles of men and animals. Man has possessed machines for many centuries, but only during the last hundred years has he found adequate sources of energy with which to run them.[1]

It was the development of steam-powered prime movers which enabled western man to lift his standard of living from the starvation level of ancient times. Electricity allowed him to apply power wherever it was needed, and the internal combustion engine gave him a freedom of movement which horse-drawn vehicles and wind-powered ships could never afford.

Today, adequate use of energy is the best criterion of the standard of living which the nations of the earth can enjoy. Figure 1 shows how direct is the correlation between national income and the use of energy[2]. Mere possession of resources, as in the case of the oil-wealthy Near East nations, is not enough to assure high living standards. The resources must be put to work. Today's world energy demands, approximately 100×10^{15} Btu per year, come mainly from the 30 per cent of the earth's inhabitants who live in North America and Europe. When the remaining 70 per cent emerge from their subsistence level, the world-wide demand will multiply to such magnitude that man's ingenuity will be taxed to the utmost in finding adequate energy supplies. By the year 2000 A.D., the world demand may well surpass 1000×10^{15} Btu per year.[3]

Two factors must be considered in any effort to foresee how much energy will be needed in the future. The 1st is the unprecedented increase in the absolute amount of energy which is being used each year. So rapid was this increase during the past 50 years, and so much more rapid will it be during the next 50, that reserves once thought to be adequate for many centuries will be seriously depleted before this century draws to its close.[3]

The 2nd factor is the shift from the constantly renewed *income energy* of wood, wind, and water to almost complete reliance on *capital energy* in the form of fossil fuels. The energy which can be released by atomic fission, while potentially greater in total amount than that of all the fossil fuels, still represents a withdrawal from our energy bank account. Still far in the future is the useful application on earth of the hydrogen isotope fusion process which now operates only in the sun and other stars.

The only *inexhaustible* energy source known today, and one which is potentially greater than any conceivable demands which man can make, is solar radiation. All the fossil fuels and all the power of wind and water arise from sunshine, past and present. A new appraisal of this, our only income energy, is certainly in order today when our expenditure of capital energy is so prodigious.

Production and consumption of our energy sources from the beginning of the century up to 1975 are shown by the data in Tables 1–6 and Figs. 2, 3, and 5.

The Author
JOHN I. YELLOTT

About the Author — John I. Yellott, assistant director of Stanford Research Institute, and Secretary-Treasurer of the Association for Applied Solar Energy. He is setting up the Institute's solar energy research program.

Before his appointment to SRI, he was for 10 years director of research of the Locomotive Development Committee of Bituminous Coal Research, where he earned an international reputation for his development work on the coal-burning gas turbine.

Before that he was well known in education and industrial research. He taught at the University of Rochester, Stevens Institute of Technology, and Illinois Institute of Technology, where he was head of the Mechanical Engineering Department and for 2 years Director of the Institute of Gas Technology, also first consultant to the Metallurgical Laboratory at the University of Chicago.

In a later article Mr. Yellott will discuss the availability of solar energy and describe the devices now being used to harness solar radiation.

Table 1. Relationship between population[1] and energy supply[2]

Year	1850	1900	1950	Estimated[3] 1975
Population, Millions	23.2	76.1	151.7	228
Total energy input Btux10 ^{15}	2.58	9.85	34.15	75.60
Per capita energy. Btux10 ^{6}	111.0	129.0	225.0	332.0
Coal Equivalent Million Tons, total	98.57	376.0	1,302	2,887.3
"Income Energy"—expressed as million tons of coal				
Animal labor	0.656	2.041	0.99	0.45
Wind and sail	0.14	0.115	0.018	0.01
Water Power	7.8	12.02	45.725	76.4
Wood	81.6	76.92	37.04	20.00
Total	90.195	91.096	83.773	96.860
"Capital Energy"—in million tons of coal or equivalent in fluids				
Coal, Bituminous	4.22	207.44	453.76	840.000
Coal, Anthracite	4.16	53.82	38.68	
Petroleum	—	13.95	468.53	1,110.000
Natural Gas	—	9.70	257.76	764.000
Total	8.38	284.90	1,218.00	2,714.000
Atomic energy—equivalent in million tons of coal				76.400

[1] U. S. Census Estimates, July 1st of each year
[2] Reference 2, p. 1114
[3] Pratt, Reference 11

Table II. Consumption of bituminous coal in the United States

Figures in millions of short tons

Year	Total	Electric Utilities	Railroads	Coke, Steel, Cement Mills	Other Industrial	Retail
1920	509.0	37.1	135.4	n.a.	n.a.	n.a.
1930	455.0	42.9	98.4	n.a.	n.a.	n.a.
1935	356.0	30.9	77.1	65.7	96.9	84.0
1940	431.0	49.1	85.1	97.0	110.5	87.7
1945	560.0	71.6	125.1	109.6	129.6	121.8
1950	454.0	88.3	61.0	119.4	98.2	86.6
1955	362.0	115.2	17.4	98.4	78.9	52.6

and Appraisal

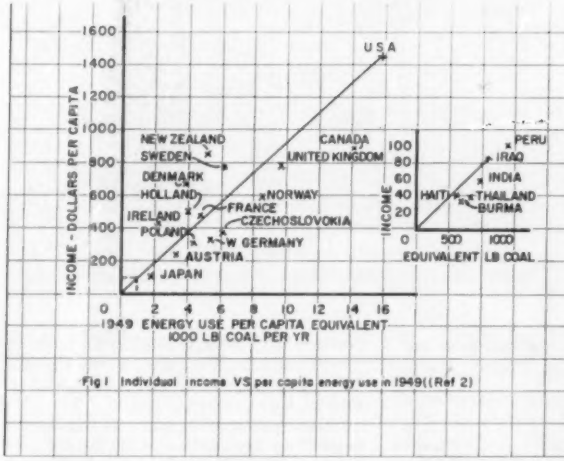


Fig 1 Individual income VS per capita energy use in 1949((Ref 2)

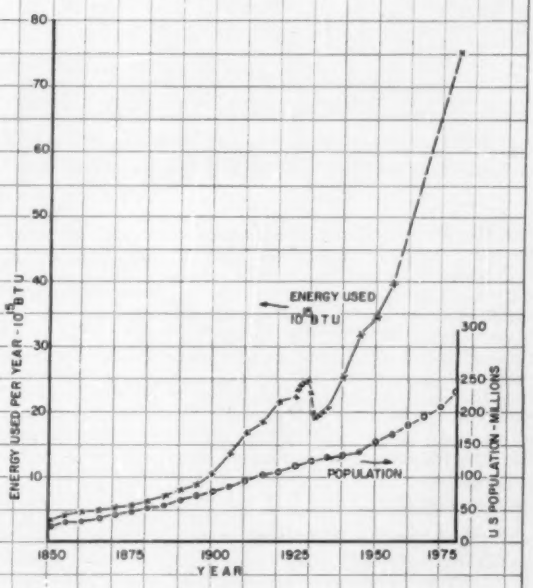


Fig 2 U S Population and energy use 1850-1975

Table III. Energy consumption, total[1] and per capita, 1900–75

Totals expressed in Btu x 10^{15}; Per Capita in Btu x 10^{6}

Year	Overall Total	Overall Per Capita	Coal Total	Coal Per Capita	Oil Total	Oil Per Cap	Gas Total	Gas Per Cap	Hydro Total	Hydro Per Cap
1900	7.89	103.5	7.02	92.2	0.36	4.9	0.25	3.3	0.25	3.3
1910	15.37	166.5	13.07	141.6	1.21	13.1	0.54	5.9	0.53	5.0
1920	20.13	189.0	15.50	146.0	3.02	28.4	0.86	8.2	0.73	6.9
1930	22.74	184.0	13.43	109.0	6.14	50.0	2.20	17.9	0.75	6.1
1935	19.72	155.0	11.18	87.5	5.78	45.3	2.06	16.1	0.80	6.3
1940	24.00	182.0	12.53	95.0	7.66	58.0	2.93	22.2	0.88	6.7
1950	34.42	227.0	12.91	85.1	12.91	85.1	7.02	46.3	1.57	10.4
1954	36.71	238.0	10.14	63.0	15.40	95.8	9.72	60.4	1.44	9.0
1960[2]	47.00	261.0	15.00	83.5	18.00	100.0	12.0	66.7	1.50	8.4
1965	55.00	284.0	17.00	88.0	21.00	108.5	15.0	77.6	1.70	8.7
1970	65.00	311.0	18.00	86.1	26.00	127.0	17.5	84.0	1.90	9.1
1975	75.00	330.0	22.00	96.5	29.00	127.0	20.0	88.0	2.00	8.8

1900–1954 Data from Statistical Abstract of the U. S. 1956.
[1] Wood omitted from totals
[2] Data from W. E. Pratt. Reference 11
[3] Data from 1960–1975 estimated from Fig. 6

Table IV. Electric Utility data for U. S. from 1920 to 1975

Year	Installed Capacity 1000 kw	Total Output Billion kwh	Output from fuels Billion kwh	Fuel used Coal Equiv. Million tons	Per cent from coal	lb coal per kwh
1920	12,720	39,400	23,495	35.8	74.1	3.00
1930	32,384	91,112	59,922	47.6	85.0	1.60
1940	39,927	141,837	94,516	62.9	81.0	1.34
1950	68,919	329,141	233,203	138.4	66.1	1.19
1955	114,371	546,404	433,684	206.0	69.4	0.95
1960	167,000[3]	755,000[1]	600,000	264.0	71.0	0.88
1965	232,000[3]	956,500[1]	785,000	322.0	74.0	0.82
		(1,040,000)*	(850,000)	(345.0)		
1970	300,000[3]	1,173,000[1]	1,000,000	400.0	78.0	0.80
1975	438,000[3]	1,419,000[1]	1,280,000	485.0	80.0	0.76
		(2,000,000)*	(1,800,000)	(684.0)		

Sources. References 3, 5, 9, 11
Atomic Plant Capacity as estimated in Reference 11
1960, 0.8 million kw
1965, 4.0 million kw
1970, 12.8 million kw
1975, 48 million kw
* from Sporn, Reference 7
(1) Ref 5, p 528
(2) Estimated by extrapolating 1955's trend to 8,000 Btu/kwh min in 1975
(3) From Ref 11, p 134

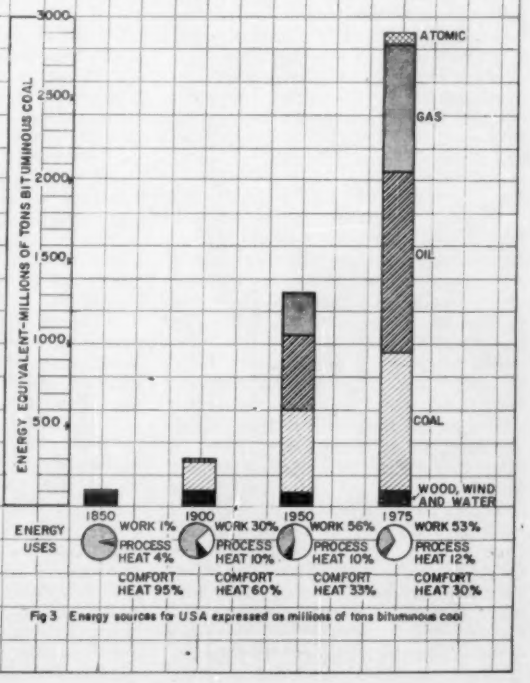


Fig 3 Energy sources for USA expressed as millions of tons bituminous coal

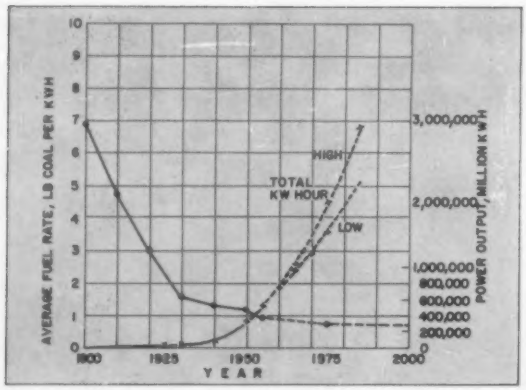


Fig. 4. Electrical output and average fuel rate for U. S. utilities. High and low estimates given for future kwh

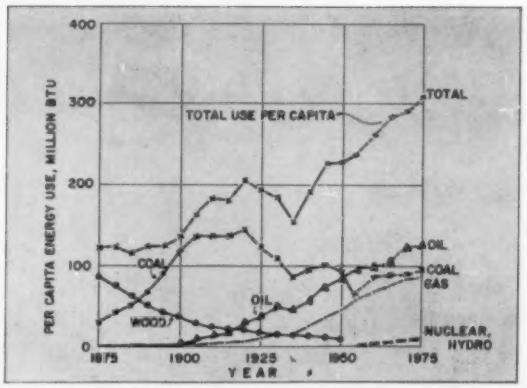


Fig. 5. Per capita energy use in U. S. by sources. Wood omitted after 1950. Nuclear power added after 1960

Growth in prime mover horsepower is the most significant index of the progress made during the past ten decades. The 23,200,000 U. S. inhabitants of 1850 shared the use of about 8,500,000 hp, or 0.366 hp apiece. Just before the dawn of the Automotive Era, in 1900, 106,500,000 people were making use of 65,000,000 hp, or 0.61 hp per capita. Fifty years later, 151,700,000 people found 4,748,000,000 hp at their joint disposal, or 31.2 hp for each man, woman and child.

Future Energy Requirements

Forecasting the energy requirements of the next 20 years can best be accomplished with the aid of the population growth curve of Fig. 2 and the energy source and use data of Figs. 3, 5, and 6. Population trends, as estimated by the U. S. Census Bureau [5] will continue upward towards a figure of at least 228,000,000 in 1975. The total amount of energy needed may well be more than twice as much as we use today for 168,000,000 people. The furnishing of this energy will strain to the utmost our nation's capital stock of both money and energy.

Petroleum

To consider first the fluid fuels which today supply 62 per cent of our needs, we must try to balance the increasing demand against the factors which are likely to affect the supply of oil and gas.

We possess at best only a fragmentary knowledge of the true extent of the world's fluid fuel reserves, and the extent to which these will be recoverable at reasonable prices is even more uncertain. Recoverability is primarily a matter of cost, since we have learned how to explore and drill at great depths below the surfaces of both land and sea.

If the oil reserves of the Near East continue to be available, the consumption of petroleum products and natural gas will undoubtedly increase greatly during the next 2 decades. Today's American demand is about

Table V. Total production and consumption of petroleum, U. S. and world

	U. S.			World
	Production	Consumption		Production
Year	Billion Bbl	Billion Bbl	Bbl per Capita	Billion Bbl
1910	0.210	0.206	2.27	0.328
1920	0.443	0.540	4.16	0.689
1930	0.898	0.936	7.30	1.412
1940	1.353	1.344	10.30	2.144
1945	1.713	1.743	12.50	2.595
1950	1.974	2.116	13.02	3.802
1955	2.485	3.100	15.01	5.3
1960[1]	3.100	3.600	19.60	6.5
1965	3.650	4.150	21.60	7.8
1970	4.300	4.70	22.50	9.1
1975	5.000	5.30	23.2	10.6

Sources: 1910 to 1955, Ref. 3. p. 740
1955 to 1975, Ref. 11. p. 137
[1] 1960–1975 Interpolated from data by W. E. Pratt.

3,100,000,000 barrels per year [10], and the expected 1975 requirement is 5,300,000,000 barrels or 30.8×10^{15} Btu, equivalent to 1,200,000,000 tons of coal. The per capita allotment for the expected 228,000,000 U. S. inhabitants would be nearly 130,000,000 Btu, or some 56 per cent more than today's figure of 87,000,000.

The U. S. began in 1948 to import more oil than it exported. Our imports are increasing at the rate of 70,000,000 barrels per year, and in 1956 we will need nearly 500,000,000 barrels from foreign sources. World production outside of the U. S. is now about 3,200,000,000 barrels per year and is increasing at an annual rate of about 230,000,000 barrels, or 7.2 per cent. World demand, exclusive of the U. S., is increasing at 10 per cent per year and is expected to equal production in 1959. The 700,000,000 barrels which the U. S. will need to import in that year will create the major part of the first serious petroleum shortage which we will experience. With the most optimistic expectations as to recoverable reserves, the earth's bank balance of petroleum and such oil-bearing substances as oil shale and tar sands is simply not big enough to sustain the 1975 rate of oil utilization beyond the end of this century.

Any estimate which attempts to penetrate the veil of the future beyond 1975 can only be considered as a guess. The deterring effect of rising cost is likely to be the most important factor in checking the apparently unlimited rise in America's thirst for petroluem and its products.

Natural Gas

Demand for natural gas has increased even more rapidly since World War II than the requirement for its hydrocarbon relative, petroleum. From 2.86×10^{15} Btu in 1940, consumption rose to 6.753×10^{15} Btu in 1950, and the 1955 figure was 10.1×10^{15} Btu. At an estimate of 85,000,000 Btu per capita, the 228,000,000 inhabitants expected by the Census Bureau in 1975 will require 19.3×10^{15} Btu, the equivalent of 745,000,000 tons of coal. In gas measuring units, this production would be 18,000,000,000 MCF.

If these estimates are even close to being correct, the amount of natural gas consumed during the next 20 years will be nearly 300×10^{12} cu ft. Proven reserves in 1954 were 211×10^{12} cu ft; Ayres [8] estimates that 250×10^{12} cu ft is closer to reality and another 350×10^{12} are geologically possible. Using his total of 600,000,000,000 MCF (650×10^{15} Btu), we may expect our gas supplies to become a matter of serious concern well before the end of this century.

Hydroelectric Power

The only income energy aside from wood and farm wastes which continues to play a significant role today is hydroelectricity. At the end of 1954, the installed U. S. hydro capacity was 24,200,000 kw while an estimated 82,800,000 kw of water power remained undeveloped. Half of this potential is in the Mountain and Pacific states. A reasonable esti-

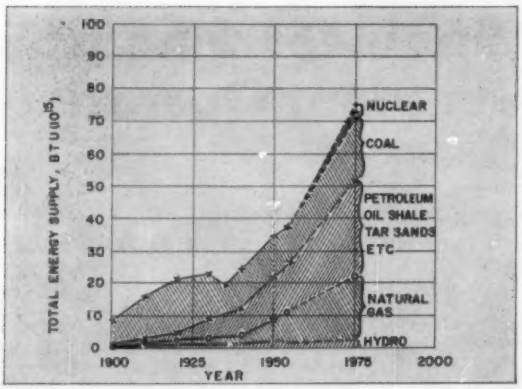


Fig. 6. Total energy from different sources used in the U. S., 1900 to 1975, omitting wood, wind and solar energy

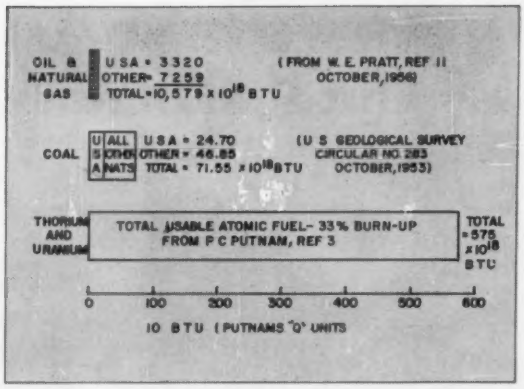


Fig. 7. Shows estimated world fuel reserves. 1956 consumption 0.1 Q. Estimated 1975 world consumption 0.2 Q

Table VI. Estimate of the total capital energy assets of U. S. and the world

Figures expressed in 10^{18} Btu ("Q" units)
A. Fluid Hydrocarbons. Oil Shale, Tar, Sands, etc. (References 6, 8, 11—These data from W. E. Pratt)
Proven Reserves of Oil and Gas, as of Dec. 31, '54

	U. S. A.	Other Nations	Total
Petroleum	0.203	1.573	1.778
Natural Gas	0.228	0.142	0.470
Total Proven	0.431	1.717	2.248
Total Economically Recoverable Oil and Gas			
Petroleum	0.700	4.060	4.760
Natural Gas	0.780	3.170	3.950
Total	1.480	7.230	8.710
Oil Shale and Tar Sands			
Oil Shale	1.740	?	2.000
Tar Sands	?	0.029	0.029
Total for all sources	3.320	7.259	10.739
B. Coal (Reference 10)			
Total in earth	49.400	93.700	143.100
50 per cent recoverable	24.700	46.850	71.550
C. Atomic Fuels (Ref. 3)			
Total Thorium and Uranium	?	?	575.000

mate for hydroelectric energy output in 1975 is 2×10^{15} Btu.

Coal

Prior to the depression of 1929–1935, coal was the nation's prime source of energy. In 1925, the United States used 15.2×10^{15} Btu in the form of 580,000,000 tons of coal. The per capita consumption of coal reached its peak in 1910 at about 142,000,000 Btu per year. The gradual decline of the next 15 years was accelerated by the depression which reduced industrial output, railroad traffic, and, in fact, virtually every component of the economy. The recovery of the early 1930's was followed by the war-stimulated demand which boosted coal production to 683,000,000 tons or 17.75×10^{15} Btu. Per capita consumption rose above 100,000,000 Btu during the war years, but the ready availability of competitively priced oil and gas then drove the individual use of coal below 80,000,000 Btu per year.

The future of the coal industry is tied closely to the generation of electricity in central stations. The vast domestic reserves of coal and the new stability of its labor force combine to offer an energy supply which will be able to expand to meet the needs of the approaching decades. The shift back to increased emphasis on coal as boiler fuel is already under way, and this trend is sure to accelerate during the next decade. In 1953, coal accounted for 65 per cent of the fuel-generated electricity. During the first half of 1956, 71 per cent of the nation's steam-station output came from coal.

The most comprehensive picture of the U. S. coal resources is given in Geological Survey Circular 293 [10] published on October 1, 1953. In this document, the recoverable coal reserves which lie under some 14 per cent of our nation's surface are analyzed in terms of thickness of seams and overburden, fuel rank, and degree of certainty with which each estimate was made. According to this survey, measured and indicated reserves in beds 28 or more in. thick and less than 2000 ft below the surface are more than 300 times 1955's production. "On any basis of analysis, the coal reserves of the United States are very large and give comforting assurance that the fuel needs of the nation can be met in any contingency for many *decades* to come." Ayres [8] has voiced his opinion that coal production in the United States will reach a peak at about 725,000,000 tons per year in 1970 and then diminish. This estimate is based upon his conclusion (from reference [10]) that only 27,000,000,000 tons are still available at today's standards of cost and quality.

Coal industry spokesmen foresee much higher annual production rates and total outputs. Philip Sporn [7], speaking before the Atomic Energy Committee of the National Coal Association, estimated that electric generation alone will require 218,000,000 tons of coal in 1965, and 515,000,000 tons in 1975. Corresponding total tonnages for all purposes would be 570,000,000 in 1956, and 900,000,000 in 1975. No less an authority than John L. Lewis agrees with these estimates.

Much thought has been given to producing synthetic liquid fuels from coal. For many reasons, it is highly probable that sub-bituminous coal and lignite will be the principal contributors to the synthetic fuel program. Ayres estimates that 21,000,000,000 tons of these low-rank fuels can be mined at costs low enough to make the resulting gasoline competitive in price with petroleum based products. The Geological Survey [10] estimates that we have nearly 420,000,000,000 recoverable tons of these fuels. Most of the tremendous low-rank reserves are in the arid and mountainous regions of the West where water for processing and means for transporting the product are equally absent.

Tremendous oil shale deposits of Colorado, covering 1000 square miles, are estimated to contain the equivalent of 100,000,000,000 to 500,000,000,000 barrels of oil. The problem of mining and processing the shale is formidable, to say the least, since the average yield will be only about 15 gal of oil per ton of shale and nearly 3 tons of ash will remain per barrel of liquid. Lack of water and remoteness of sites are major obstacles, but it is not too far-fetched to envision a products pipe line following the Colorado River as it winds from Rifle to the Gulf of California.

The balances which remain on deposit in the World Bank of Fossil Fuels are being subjected to increasingly heavy withdrawals. Before the turn of the century, the fluid fuels will be *continued on page 126*

Effective Start-Up Engineer Smooths Out Preliminary Power Plant Operation

In preliminary operation of a new power plant, why do you need a start-up engineer? He must be a seasoned power plant man, but his most important job is to coördinate the interests of the plant builders and the plant operators. Here's how it's done effectively

By J. H. HUNNICUTT*

AS A NEW power generating station nears completion and the project enters the early stages of preliminary operation, the client company for whom the plant is being built will frequently request the contractor who designed and constructed the plant to provide assistance in starting up the new installation.

Why? Does it imply that the client, who after all has been operating similar units for a good many years, is incapable of placing the new unit in operation? Not a bit! But in order to fully appreciate the desirability of this proposed procedure, it is necessary to examine for a moment the nature and scope of the service requested.

The engineer assigned to this work will, of necessity, be a specialist. In some engineering companies he will bear the title of power engineer; in others he will be unglamorously but aptly termed a "start-up engineer." Regardless of title, he will fit into a predetermined mold insofar as background and experience are concerned.

Almost without fail, he cut his engineering eye teeth in plant operation and has a solid background of operating experience. Problems of plant efficiency and reliability are no strangers to him; and, from the point of view of the client's operating personnel, he has "been through the mill." He speaks their language.

Why a Start-Up Engineer?

Assume now that ABC Power Co has retained the Blank Engineering Corp to design and construct a new generating station. At the outset, all negotiations were at the executive level. An economic study was made, problems of financing the project were met and a plant site selected. Blank Engineering assigned a project engineer, the plant was designed and construction reached an advanced stage of completion. At this point, two forces come into play with interests that, if not diametrically opposed, certainly are not identical.

Blank Engineering Corp has assigned their best construction superintendent to the project. He was chosen because of his reputation for getting a plant built in the time allotted with a minimum of labor difficulty, and for keeping well within the budget. He is acutely cost conscious. Blank Engineering Corp is acutely cost conscious. That, in the final analysis, is why ABC Power Co engaged Blank Engineering Corp in the first place. The construction superintendent is not a plant operator nor is he expected to be. He builds what Blank Engineering Corp designs — and he does an admirable job.

ABC Power, on the other hand, has an operating superintendent. He, too, is budget conscious, but his budget is of another kind. From past experience, he knows that any operating refinements or additional equipment he may desire will be almost impossible to attain unless they are included in, and capitalized with, the overall installation. Frequently he may desire minor design modification or addition to satisfy a peculiar operating condition in that particular plant that was not brought to light during the design phase of the project. If the installation is an entirely new plant rather than an extension to an existing one, quite likely the operating superintendent is newly appointed, with a supporting staff drawn from other stations in the ABC system, all newly promoted and subject to an understandably human desire to "cut a swath." The lines of organization and authority will not have had time to harden and, where this situation exists, conscientiousness frequently compounds confusion with ideas rampant for "gilding the lily" and sinking the budget to the detriment of all concerned. Add to this the burden of training additional personnel and the necessary scheduling of operations, and you have a picture of tremendous responsibility on both the construction superintendent of Blank Engineering Corp and the operating superintendent of ABC Power Co, both striving to arrive at the same ultimate goal via different approaches.

What He Does

It is into this critical situation that the start-up engineer is projected. His immediate concern is with the

* Power Engineer, United Engineers & Constructors, Inc

HERE IS the first of a group of related articles — call it a series if you wish — covering the various operations necessary to get a new steam-electric power station ready for commercial operation. Many POWER ENGINEERING readers may have been through this procedure, but we have never seen the details set down on paper before. And the author, as you will see from his biography, is an expert in start-ups. That's his principal job. So he is going to write on the following vital steps in starting up a new plant, covering each of the procedures in a separate article:

Cleaning of Auxiliary Piping

Inspecting, Cleaning and Testing of Tanks, Condenser and Feedwater Heaters

Running-in Rotating Equipment

Cleaning the Boiler Feedwater System

Sore Spots to Avoid in the Circulating Water System

Checking, Testing and Pre-setting Instrumentation and Controls

The Boiler

A. Hydrostatic Test
B. Boil Out and Acid Wash
C. Setting Relief Valves

Blowing Steam Lines

The Turbine

A. Hydrostatic Test of Hydrogen and Lube Oil Coolers
B. Air Test of Hydrogen Cooling System
C. Oil Flush

Preliminary Operation

Perhaps this unusual and practical series will ultimately result in a book. Both the author and the editors will welcome your comments on the idea of this series and on the individual articles as they appear.

Final step in placing new power plant in operation after start-up engineer has carried out his responsibilities. William C. MacInnes, president of Tampa Electric Co, phases the No. 5 unit at Hookers Point Station into system for first time

checking and running-in of rotating equipment, the cleaning of duct systems, the thorough flushing of all lines in the service and cooling water systems, the inspecting and closing of tanks, deaerating heater and condenser, the witnessing of various hydrostatic tests, the boil-out and final cleaning of the boiler, the setting of relief valves, the blowing out of steam lines and, ultimately, the initial operation of the installation. These are the obvious, routine, cut-and-dried, common-to-every-plant functions of the start-up engineer. They require no special talent beyond that of a competent operator. It is in yet another direction that his greatest opportunity for effectiveness lies, and this effectiveness stems from the uniqueness of his position midway between the two divergent points of view previously described.

He Must Be Skilled Diplomat

Obviously, the desires of the ABC operating personnel cannot be ignored or run over in a rough-shod manner, for even though Blank Engineering completes an operating installation on schedule and within the budget that in every way conforms to specification, a disgruntled operating staff will forever after lay the blame for every operating mishap at the door of the constructor; and frequently, though often unjustly, be successful in doing so. On the other hand, neither can the construction schedule or budget be subverted to satisfy every whim of the clients operators; for if, in the final analysis, the cost per installed kilowatt far exceeds the budget, it's a pretty safe bet that ABC won't retain Blank Engineering to build their next installation, the happiness of their operating people with the last one notwithstanding.

It follows, then, that in addition to being a competent operator, the start-up engineer must be a tactful winnower of ideas that fall into the "desirable-but-not essential" category and must be capable of diplomatically getting his point across. He must also have the necessary strength of his own convictions that will allow him to intercede for the operators when a modification is necessary to the ultimate efficiency and safety of the plant. To successfully accomplish this, it goes without saying that he must be capable of inspiring the confidence and respect of both parties.

The effective start-up engineer will have the knowledge of operating theory behind the design of the plant that the construction staff does not and cannot be expected to have. More important, he will have the ability to translate this theory into practical application in the form of instructions to the operators. Where past and time-honored operating procedures, developed on older units within the ABC system, would work to the detriment of the newer, more efficient installation, he must be capable of tactfully explaining not only the procedural change necessary but the reason behind the change. He is able to do this because, ideally, he was thoroughly familiar with the initial heat balance preliminary to design and, in all likelihood, played a prominent part in the studies that led to sizing of plant components.

Coördination Is Key Word

He will be an adroit coördinator. He must be able to effect and maintain close liaison between two organizations, each frantically busy in two different spheres of endeavor yet rapidly approaching a juncture; and must prevent one from interfering with the effective functioning of the other. He must be capable of scheduling vendors' service personnel onto and off the job in such a manner that their special abilities are used to maximum effect, without excessive service fees accruing because of delay after their arrival at the job-site.

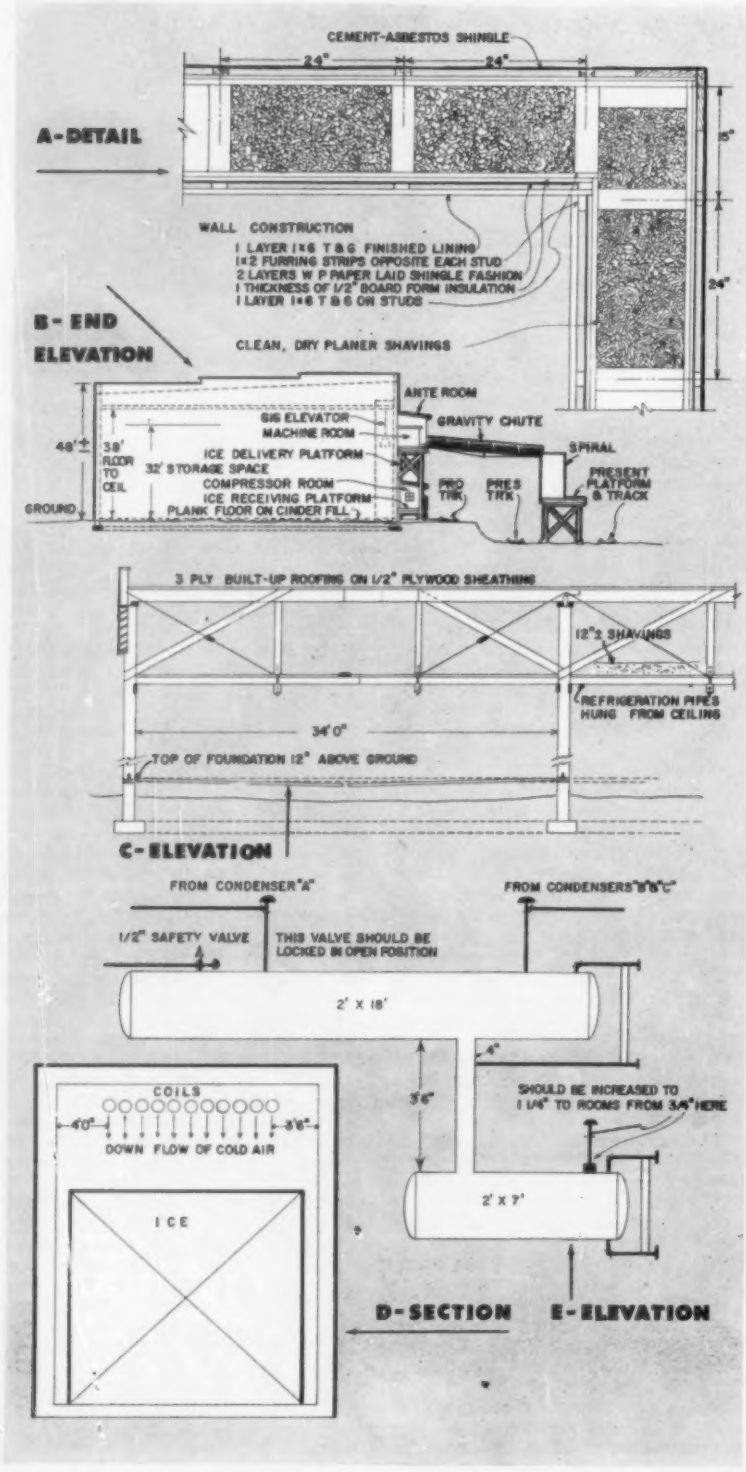
The effective start-up engineer will be constantly on the alert during the final phase of construction for items of operating convenience. Features not shown in detail on construction drawings are often left for discretionary arrangement in the field, as good operating and maintenance practice may dictate. Expediting of the client's wishes in these matters through to final installation falls within the scope of the start-up engineer, as does the dissemination of the valuable knowledge gained in every start-up to his own associates in the design group, to the advantage of all future projects.

This effective start-up engineer will, in the final analysis, play a very important role in the cementing of relations between Blank Engineering Corp and ABC Power Co. If, at the conclusion of the project, the start-up engineer has performed as his employer and the client rightfully expect him to perform, the client benefits from an efficient, smoothly operating plant with a thoroughly integrated operating force, and his employer can but gain in stature.

About the Author

J. H. HUNNICUTT is well known in public utility and industrial power circles in the United States and throughout Latin America as a start-up and plant betterment specialist. He is a product of the Maritime Academy and of Texas Agricultural and Mechanical College. Formerly with the Power Division of Stone & Webster Engineering Corp., he joined United Engineers & Constructors early in 1956 as power engineer. He has had responsible charge of the initial start-up, preliminary operation and operator-training programs of many of the larger power installations in the Western Hemisphere.

The Case of the Troublesome



By C. T. BAKER *

REFRIGERATED ICE storage building with large ice holding capacity, erected during the 2nd World War when both labor and materials were difficult to obtain, began to experience difficulty in holding safe room temperatures.

The trouble began to appear during the early part of 1954, some 10 years after the plant was constructed. The following year was still worse and during the 1956 season it was not always possible to maintain temperatures sufficiently low to prevent some meltage. The building proper was 105 ft long overall, divided into 7 rooms, each 34 ft wide with a net ice storage height of 32 ft. Approximately 18,500 tons of ice were stored each year to supply extensive car icing operations which lasted about 3 months of each 12 month period.

This refrigerating plant consisted of 3 vertical ammonia compressors having a combined capacity of 100 tons of refrigeration. The rooms are cooled with 2 in. diam direct expansion coils suspended from the ceiling.

All walls, including partitions between rooms, are insulated with 12 in. of planer shavings, as is also the ceiling. No insulation is used on the floor, which consists of a cinder fill upon which a plank floor is laid. The method used in insulating the walls is shown in Fig. 1 (A). Figure 1 (B) shows the floor arrangement and Fig. 1 (C) the ceiling insulation.

Walls are supported on concrete foundations, the footings of which are carried to hard pan. Unfortunately, no provision was made when the facilities were built to drain the area during wet weather. The ground at the south end of the building is at an elevation of about 5 ft above the ground on which the structure rests This is also largely true of the east boundary line which parallels a State Highway.

Over a period of time, the ground below the concrete foundation supporting the walls collected considerable water, as a result of heavy rains that often lasted several days and which allowed water to stand two to three in. deep adjacent to one end and one side of the building.

During the long periods over which the entire structure was under refrigeration, water froze below the foundations supporting the walls,

* Consulting Engineer

Fig. 1. Left. Details of ice storage installation. A. Wall insulation. B. Floor arrangement. C. Ceiling insulation. D. Air circulation, and E. Liquid system

Ice Storage

Many plants put up with small losses and with inadequacies because they seem too small to bother about. Not one of the faults listed in this article would, by itself, have had much effect on production, but together they made the plant fail.

causing serious damage to these foundations. At one point along one wall, the upward forces exerted by the freezing water caused the foundation wall to shear.

The cinder fill beneath the plank floor of each of the 7 rooms became saturated with water that had seeped beneath the wall footings, causing an upheaval of the flooring upon which the ice rested.

Recognizing the chances for wide and serious damage to the building as a whole from sub-soil freezing, efforts are now being made to provide effective drainage for the ground area occupied by the building.

Obviously, the building floor should have been at a much higher elevation so as to be well above maximum water line, and also provision should have been made to properly drain the area occupied by the structure.

Why It Was Difficult to Maintain Safe Room Temperatures: As mentioned at the outset of this case history, considerable difficulty was experienced during hot weather holding safe temperatures in some rooms.

In searching for the answers, several things were discovered that were exerting an influence on the problem.

Cause No. 1: The loose fill insulation in the hollow walls and partitions was filled to the ceiling line, but with no insulation carried above this line to allow for settlement. The net result of this is that a wide band around the periphery of the building, and in the partitions, is without insulation due to the settlement of the loose material which was placed in service more than 10 years ago.

In addition, the ceiling insulation has absorbed a lot of water, which has affected its insulating value.

Cause No. 2: Excessive heat leaks into the rooms from poorly fitted cold storage doors.

Cause No. 3: Five of the total of 7 rooms were found to be short on cooling coil capacity. An additional 400 lineal feet of 2-in. pipe will shortly be installed in these rooms.

Cause No. 4: High condensing pressure and liquid ammonia lines are too small. These two shortcomings are discussed later.

In addition to the causes listed above, several other factors involving the refrigerating plant exerted a very decided influence on over-all plant performance. These are as follows:

Arrangement of Cooling Coils: Figure 1 (D) illustrates the arrangement of the 2-in. direct expansion cooling coils in the 5 rooms having insufficient cooling surface.

It will be noted that on one side the distance between the center of the pipe and the wall is 3 ft 6 in. while on the opposite side this distance amounts to 4 ft. When ice is stored, the practice is to keep it away from the walls, at least 2 to 3 in., in order that air will circulate between the building walls and the ice. To accomplish this, ceiling coils should extend to within 8 to 10 in. of all walls.

It is apparent from the arrangement shown in Fig. 1 (D) that air circulation between the building walls and the ice is not adequate to insure that heat entering the space between the ice and walls is readily transferred to the coils above. This condition can, and often does, cause meltage of ice along the walls.

This condition will be remedied when the additional 400 lineal ft of coil is added to these rooms.

Failure to Provide By-Pass Results in Trouble: When installing the cooling coils, a full size by-pass was provided around the thermal expansion valves at each room, but unfortunately this practice was not followed in the case of the solenoid valves on either the liquid supply line to the individual room or the suction outlet of the coils of each room.

Recently, the solenoid valve on the liquid line to one of the rooms failed and had to be removed from service for repairs.

During the time required to recondition this piece of equipment, the temperature in the affected room reached a level above freezing sufficient to cause an almost complete melting of the frost and ice on the cooling coils. The resulting water, falling on the top layer of ice, froze when refrigeration was restored, thereby causing many of the ice cakes to freeze into one solid mass. Of course, this condition made ice removal quite difficult.

A full size by-pass is being installed around all solenoid valves to permit their removal for repairs in the event of trouble.

Still another shortcoming of the original solenoid valve installation was the fact that none of these 14 valves included in the system were protected against damage from grit and foreign matter by pipe strainers.

Small Liquid Supply Line Gives Trouble: Taking into account the tonnage required to cool these rooms during period of maximum heat leakage, the length of the liquid line between the liquid receiver and the coils, plus numerous right angle elbows, a liquid line not less than 1¼ in. diam should have been installed. Actually, a ¾-in. line was selected, which is reduced at the liquid receiver, as shown in Fig. 1 (E).

The plant engineers reported that the liquid line would frequently frost at different points near the coils before reaching the thermal expansion valves. This condition, of course, was positive proof of pressure loss in the liquid line. This produced flash gas ahead of the expansion valves, a condition that not only prevented an adequate supply of liquid reaching the coils but also interferred with the regulation of the expansion valves. Incidentally, flash gas passing expansion valves decrease the net refrigerating effect of the cooling coils.

This condition will be corrected by installing a 1¼ in. liquid line connecting the receiver and liquid header of the cooling coils.

It will be observed in Fig. 1 (E) that 2 large liquid receivers are provided with only 1 safety relief valve. It will be observed also that a hand stop valve is placed between the safety valve and receiver. These receivers will each shortly be fitted with A.S.R.E. Code dual safety valves size ½ in.

Faulty Liquid Drain Line: The liquid line A in Fig. 1 (E) drains 1 of the 3 evaporative condensers in service. At a point some 2 ft distant from the liquid outlet of this condenser, the liquid line was found to be approximately 4 in. above the condenser coil, thus forming a trap which naturally prevented free flow of liquid from condenser to receiver. The line is being lowered to insure a good fall between condenser and receiver.

Poor Compressor Cylinder Cooling: A practice that generally results in a heavy troublesome deposit in the jackets of refrigerating compressors is that of supplying these jackets with cooling water from the spray pump of evaporative condensers.

In the installation under discussion, this method had been in use since the plant was built. Recently the jackets of one of the compressors became so plugged with deposits from the condenser spray water that they had to be removed from service for cleaning to prevent further overheating of the cylinders.

It should be remembered that water, when evaporating in evaporative condensers and cooling towers, leaves behind much in the way of soluble solids and that such highly saturated water is not a suitable medium for compressor jacket cooling.

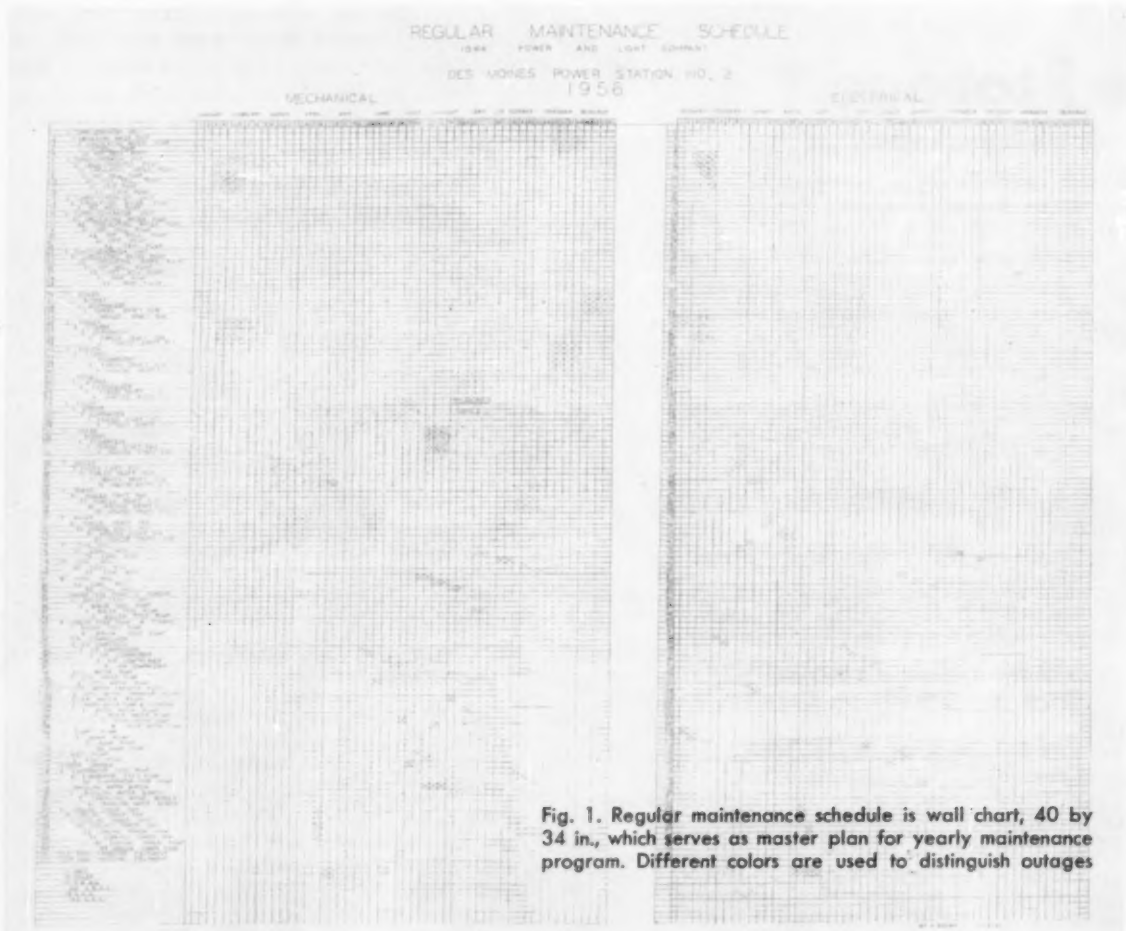


Fig. 1. Regular maintenance schedule is wall chart, 40 by 34 in., which serves as master plan for yearly maintenance program. Different colors are used to distinguish outages

Maintenance Is a Business—Make It

Fig. 2. Maintenance card for individual item of equipment; contains nameplate data, date installed, other information

This second article on Retentive Maintenance program covers the *how* of the system; Previous article dealt with the *why*. Success of this approach to maintenance at Iowa P&L attests to its value

By CHARLES T. MAXWELL*

INITIATION OF A Retentive Maintenance program is, like maintenance itself, a continuing process. Thorough planning is a basic requirement which can eliminate loss of much valuable time and money. A great deal of information is readily available concerning the experiences of all types of plants with various approaches to the field of maintenance scheduling. Study carefully the successful parts of these programs, observe them in action, note the most valuable procedures and those which seem to be nonproductive or have been abandoned, and necessity for the trial and error method will be practically eliminated.

Major items at most stations have, of course, been under scheduled maintenance for many years, and recently a great deal of material has been developed concerning intensified scheduling and the compilation of adequate historical records. The two are complementary and mechanically interlocked. Fundamental tools used frequently and with outstanding success are the following:

1. **Regular Maintenance Schedule** (Fig. 1) is a chart showing the schedule of all items by weeks of the years. Scheduled outages, actual outages as they occur, and emergency outages are shown in contrasting colors. The chart serves as a master plan and provides an immediate visual record of all outages which have occurred

* Registered Professional Engineer, Assistant Maintenance Superintendent, Iowa Power & Light Co

Fig. 3. (Left) Inspection and maintenance sheet, prepared for all classes of equipment. Fig. 4. (Below) Man-hour record shows names of all men on jobs

COAL MILL

Class of Inspection _____ INSPECTION AND MAINTENANCE SHEET Date _____

Number _____ Mfgr. _____ Type _____ Ser. # _____

Ring

Rolls

Upper Mill Side Liners

Bowl Deflectors

Scraper Guards and Holders

Other Liners

Classifier Vanes and Inner Cone

Journals

Drive Gear Unit

Dampers

Auto. Controls

Exhauster

Liners

Fan Blades

Whizzer

Spider

Damper

Auto. Controls

Miscellaneous

Total Man-Hours:

Workmen:

Remarks

Report by:

Month - Year _____

Anderson, Charles, Davis, Dickman, Farris, Hansen, Harris, Ivey

Class _____ Job:

TIME SLIPS SEPTEMBER 1956 Page Of

DATE	S	O	D	S	O	D	S	O	D	S	O	D	S	O	D	S	O	D	S	O	D	S	O	D
1	0			0			0			0			0			0			0			0		
2	0			0			0			0			0			0			0			0		
3	A			V			A			A			8			8			8					
4	8			V			8			8			8			8			8					
5	8			V			8			8			8			8			8					
6	8			V			8			8			8			8			8					
7	8			V			8			8			8			8			8					
8	0			0			0			0			0			0			0					
9	0			0			0			0			0			0			0					
10	8			V			8			0			8			8			8					
11	8			V			8			8			8			8			8					
12	8			V			8			S			8			8			8					
13	8			V			8			S			8			8			8					
14	8			V			8			S			8			7	A		7					
15	0			0			0			0			0			0			0					
16	0			0			0			0			0			0			0					
17	8			8			8			8			8			8			8					
18	8			8			8			8			8			8			8					
19	8			8			8			8			8			8			8					
20	8			8			8			8			8			8			8					
21	8			8			8			8			8			8			8					
22	0	8		0			0			0			0			0	8		0					
23	0		8	0			0			0			0			0		8	0					
24	8			8			8			8			8			8			V					
25	8			8			8			8			8			8			V					
26	8			8			8			8	2		8	2		8			8					
27	8			8			8			8			8			8			V					
28	8			8			8			8			8			8			V					
29	0			0			0			0			0			0			0					
30	0			0			0			0			0			0			0					
31																								
	8	8	8	80			160			168	2		152	2		159	8	8	136			120		
S										24									32					
A	8									8			8			1								
V				80																		40		
H	Holiday																							

Maintenance Department

Man-Hour Record

Report Made:

Remarks: Utility Mechanics

	TOTALS			
	S	O	D	T
	1107½	200	16	1423½
S				224
A				25
V				120

Produce! Part II

or are expected throughout the plant.

Unfortunately, the large size of the chart does not permit good reproduction on the small scale necessary here. The original is 40 by 34 in. and carries a listing of all major equipment.

2. **Tickler Card** (Fig. 5) file contains a card for each item scheduled for inspection, filed according to the week in which the item is scheduled. Each week the items scheduled for attention are removed and the proper assignments of the work made.

3. **Inspection and Maintenance Sheets** (Fig. 3) are prepared for all classes of items which are to be under scheduled maintenance. These itemize most parts to be inspected and reported on, and are issued to the inspecting mechanic prior to the inspection and filled out by him, then checked and typed. Space is provided for recording man-hours. The sheets are filed under the proper heading in loose-leaf notebooks for ready availability.

COMPRESSOR, AIR, #4

WEEK SCHEDULED	INSP NO	WEEK INSPECT	REPORT REC'D	INSPECT BY	REMARKS
23-53	A	23-53	24-53	Wittler	Extensive - see report
21-54	A	23-54	24-54	Hadsall	Will need re-bore
21-55	A	25-55	27-55	Hadsall	Re-bore - see report
22-56	A	22-56	23-56	Wittler	Normal wear
22-57	A				

Fig. 5. Tickler card is on file for date when inspection of item is due. Cards are pulled each week to make assignment of work; report on item (Fig. 2) is noted and card re-filed

UTILITY MECHANICS — JUNE 1956

	ST	OT	DT	TT
Scheduled:				
#61 Hot Well Pump	107½	16	10	133½
#61 Hot Well Pump Motor	32	12		44
#10 Burners	16	32	40	88
#10 Induced Draft Fans	5	42½	30	77½
#10 Boiler	62			62
#10 Safety Valves	9	4½		13½
#61 Coal Mill	218			218
#62 Circ. Water Pump	88½	39	39	166½
#6 Unit Valves	4			4
#6 Cooling Towers	78			78
#10 Soot Blowers	8			8
#101 Bearing Water Pump	5			5
#61 Drip Pump #61 Heater	7			7
#101 Heat Exchanger Pump	6			6
#101 Ash Sluice Pump	12			12
#9 Boiler Valves	67			67
#91 Induced Draft Fan	49½			49½
#91 Hyd. Coupling Oil Pump	6			6
#91 Dust Collector	30			30
#9 Ash Pit	18			18
	862½	146	119	1127½
Emergency:				
#61 Evaporator	4			4
#1 Boiler F. W. Regulatpr	6			6
#72 Coal Mill	21			21
Coal Handling	206	22		228
Large Desuperheater	8			8
#6 Air Compressor	36½			36½
#1 Turbine	4			4
#51 Evaporator Feed Pump	11			11
#1 Ash Pump	40			40
#1 Travelling Screen	6½		10	16½
#52 Evaporator Feed Pump	19			19
#5 Stoker Spout Swinger	18			18
#5A Cooling Tower Motor	6			6
Ash Disposal	70			70
#102 Control Air Compressor	14½			14½
#6 Turbine	162	156	58	378
	634½	178½	68	880½

Fig. 6. Monthly utility mechanics report, showing straight time, overtime, and doubletime. This totalizing report is made up from man-hour record in Fig. 4

4. **Maintenance Card** (Fig. 2) is the master card giving all pertinent information on each item (nameplate data, date installed, etc.) and on it is recorded the date and type of every inspection made, with remarks as necessary.

5. **Man-Hour Record** (Fig. 4) records the names of all men working on each job and hours of straight, over, and double time worked each day, plus the total for each man and each classification on the job. It also shows the category of the work and provides space for other pertinent information. A space is provided for a check mark showing that an Inspection and Maintenance Sheet has been filed for the work, and that entry has been made on the Maintenance Card. This should be checked before the page can be removed from the current time book, thus providing a mechanical interlock eliminating the possibility of failure to file a completed report. It is also used as a master time sheet for the entire maintenance department, showing the hours worked, days off, absences, etc., for each man each day of the month, and the monthly totals for each man and for each classification (Fig. 6). In most cases it is possible to obtain the information necessary for the above breakdowns easily through cooperation with the timekeeping department.

6. **Monthly Man-Power Compilation** (Fig. 7) consists of a list of all

DEPARTMENTAL SUMMATION — JUNE 1956

	TT	S	E	C	R
Utility Mechanics	2280½	1127½	880½	63	209½
Mech. Helpers & Appr.	1542½	745½	532½	83	181½
Machinists	416	255½	110½		50
Boiler Maintenance Men	1058½	764	256		38½
Painter-Insulator-Mech.	160			79	81
Electricians	822½	374	49½	302	97
Electrician Appr.	355½	95	15½	233	12
	6635½	3361½	1844½	740	689½
PERCENT OF TOTAL	100.0%	50.7%	27.8%	11.1%	10.4%

Fig. 7. Monthly man-hour compilation is summarized in this report listing all jobs done in each category during month

JOB SHEET
MAINTENANCE DEPARTMENT

Job No. _____
Date _____

EQUIPMENT: _____

Job Description _____

Class _____ Priority _____

Parts Necessary:	On Hand	Ordered	Delivered

Tools Necessary: _____

Labor Necessary:	Classification	Estimated	Actual

Date Begun _____ Date Completed _____ Report Made _____

Remarks:

Fig. 8. Job sheet is filled out by superintendent or his assistant when job comes up to define exact work to be done

jobs done in each category of work during the month, together with the hours worked in straight, over, and double time, the totals, and a percentage breakdown by categories. One such compilation is used for each classification.

Use and sequence of the forms is evident from the descriptions. In accordance with the Regular Maintenance Schedule and the Tickler Card file, the maintenance office prepares the necessary Inspection and Maintenance Sheets and issues them to the proper person several days in advance of the time the inspection will actually take place, enabling the work to be planned in an orderly manner. Following the inspection, the sheet is returned to the office, reviewed and discussed as necessary, then typed and filed under the proper heading in a loose-leaf notebook, forming part of a permanent historical record of the item.

Entry is then made on the Maintenance Card according to the results of the inspection, and the Tickler Card is returned to the place in the file indicating the time of the next inspection.

Begin Recording Man-Hours

Perpetual recording of man-hours should be begun at the earliest possible time, for it is the heart of the control system of the program, and the value of the records kept becomes greatly enhanced at such time as they become cyclic in nature. After several Monthly Man-Hour Compilations have been made, the relationship of the categories may be observed, and as additional monthly totals come in, trends may become evident. At such time as these trends mature, their significance may be analyzed and appropriate actions taken. These relationships and trends are well portrayed graphically, as shown in Fig. 9. The cumulative total used here is for the twelve months previous to the month indicated, which eliminates the seasonal factors and makes possible an accurate picture of trends from year to year. The percentage figures, in contrast to the absolute figures shown in the upper portion of the graph, eliminate the weight of overtime work affecting the trends.

One of the most useful tools of the Retentive Maintenance program is the Job Sheet, Fig. 8. It is filled out for each job by the maintenance superintendent or his assistant at the time the job comes up on the schedule, or, in the case of emergency work or general work, at the time the need for the work becomes apparent. Construction work is handled in the same manner as scheduled work. After the job has been surveyed and evaluated as necessary, the job sheet is filed in a loose leaf notebook under its proper category. From this convenient book, assignments may be planned and made, giving the workmen a copy of the job sheet if deemed advisable. In large central stations it may be advantageous to have the job sheets made up in duplicate or even triplicate. They may also be designed to coordinate with accounting procedures.

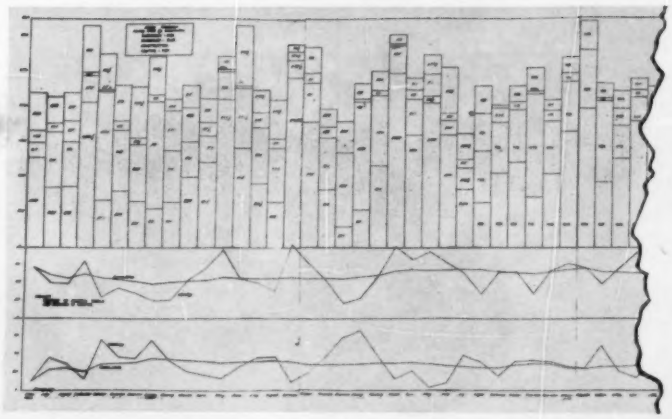


Fig. 9. Graphic portrayal of trends and relationships established by analyzing Monthly Man-hour Compilations; maintenance programs are adjusted accordingly

Advantages provided by job sheets in procurement of materials and planning of man-power and equipment use are outstanding, but there is a further advantage in that the job-sheet file provides a perpetual, accurate picture of the current workload of the maintenance department. Readily at hand is the total backlog of work in each category, which may be set forth in terms of man-hours or department-days. This information will have a vital effect on considerations of overtime warranted, rescheduling of work, undertaking of construction work, and departmental expansion.

Analyze Program

One of the fundamental principles pointed out earlier was that facts must be provided by the program by which the determination of the proper size of the maintenance department may be made, and the job sheet file makes an important contribution to this effort. Considered together with the graphic portrayal described above, and the amount of new construction work set forth for the future, the job sheet file furnishes an excellent statement of the health of the department.

It should be pointed out that the forms necessary for the initiation of a Retentive Maintenance program can be inexpensively reproduced by mimeograph or other duplicator processes, with the exception that the job sheets, if desired in duplicate or triplicate, may be advantageously printed in pad form.

A recorded history of the Retentive Maintenance program is important, and should be started with the program. Methods, forms, additions, deletions, and changes should be reported as they occur, together with their reasons. Results and measurable influences of the program should be made a matter of record. Such material is of great potential value in what should be a continual effort to improve the maintenance "business," as well as to point out the success of the modest investment. A visual record of accomplishment is always far superior to an oral report.

Program Proved Sound

At the Des Moines Power Station of Iowa Power and Light Co, a maintenance program similar to the one described has been instituted, and for the past several years has been in the process of development. The author has been intimately associated with this process. Additions, deletions, mistakes and improvements have all been a part of this experience. Perhaps the greatest difficulty has been in trying to keep some of the older equipment somewhere near schedule. This has been particularly true of the original six boilers of the station, which date from 1925, and now constitute only a fraction of the total capability of 228 Mw, but a substantial part of the headaches of the maintenance department.

All concerned with the program at Iowa Power and Light agree that efforts to establish a Retentive Maintenance program have been worthwhile, and should be continued and intensified. The investment in time, money, and supplies has been modest — indeed, negligible — in relation to the benefits obtainable. Under no circumstances should it be considered to be a deterrent to the establishment of such a program.

Considering the investment required in a modern power plant, the amount needed for this maintenance system is negligible.

In Retentive Maintenance the approach — the philosophy — is the cardinal point. The principles which must be embraced should be governing. Perspective of the whole must be maintained at all times; the means must not obscure the objective. Then only can the purpose of the central station be best served by the maintenance department.

Electrical Recovery When Disaster Strikes

Fig. 1. This is what hurricane "Hazel" did to one New England town in August 1955

THE WIDESPREAD natural disasters of recent years have made it clear that no plant can feel entirely secure against the possibility of devastation. In the hurricanes and floods of recent years, much experience has been gained in the task of restoring equipment damaged by water, wind, and fire. We have also learned — the hard way — some of the precautions that must be taken beforehand to reduce damage when disaster does strike.

The service shops of three of the country's leading electrical manufacturers have accumulated a great deal of emergency operating experience in time of disaster, and in a series of manuals and booklets they describe the lessons learned from these experiences, recommend precautions to be taken beforehand to limit disaster damage, and suggest procedures for getting high-priority electrical equipment back into service quickly once it has been damaged. These booklets are well written and give much valuable advice, based as they are on a wide range of bitter experience.

Titles of the publications are given at the end of this article, in which we quote a few excerpts to give readers an idea of the kind of information they contain.

Here is what one of the publications, dealing with the effect of floods on electrical equipment, recommends as last-minute precautions to be taken once it becomes evident that flooding cannot be avoided.

When it becomes evident that flooding is unavoidable, the following measures will minimize damage, aid in restoring facilities and equipment, and provide a greater degree of safety.

1. Shut off electrical equipment in time to allow it to cool. Insulation cracking will thus be avoided, and less water will be drawn into the insulation.
2. De-energize all controls to prevent erratic breaker actions as cables are submerged.
3. Carry all fire-fighting equipment and first-aid supplies to higher levels.
4. Store drinking water, food, protective clothing, and blankets at higher levels.
5. Disconnect cables from batteries. Remove non-sealed batteries to prevent acid leakage, but do not move sealed batteries. Experience has shown that when sealed batteries are not disturbed, a certain amount of gas pressure keeps water from washing into the cells.
6. Pump as much oil as possible into tanks and barrels on the upper levels of the plant. Fill with water the partially empty tanks and drums which must remain at lower levels to prevent their floating about, and reduce the danger of fire.
7. Seal cable boxes with roofing compound and fabric. Such sealing will not keep out all water, but the entrapped air will save part of the equipment.
8. Do not attempt to set equipment on hastily improvised scaffolds. Such structures are not likely to withstand the pressure of the water or the pounding of debris, and their collapse may cause irreparable damage to both the equipment underneath and the equipment that falls. Here is what another of the manuals has to say about restoring production.

Restoring production: Getting back into operation is a vicious circle of priorities — everything comes first. It follows, therefore, that much of what you do will be a temporary expedient, and that you can — and absolutely should — set up a program later for permanent repair and replacement.

Preliminaries: Turn off electricity, gas, and fuel lines at the source. Repair or remove safety hazards — live wires, broken fuel and gas lines. Mark obvious structural weaknesses. Select and clear an access road and a connected portion of the plant which offers the most in accessibility, safety, and ease of restoring utilities.

Fig. 2. (Right) Salvaging a transformer for reclamation in a metal-rolling mill after the New England floods of 1955

If necessary, consider bull-dozing a hole through a wall of the plant.

Records: Recover records of all electrical lines and structural prints. If not absolutely up-to-date, detail the most experienced men available to correct them to the best of their recollection — and fast.

Communications — Compile a record of the temporary addresses and emergency phone numbers of your employees — and keep it up to date. Try to obtain a battery-powered portable megaphone to direct your workers in scattered operations.

Decisions: Delegating absolute authority to make on-the-spot decisions is a must in large plants. Enough people should be delegated so there will be no delays, and their decisions fully endorsed even if hindsight proves that some were faulty.

Purchasing: When ordering replacement parts and repair materials, identify them as emergency items. Tag all equipment to be moved, using waterproof ink or pencil, and no matter how busy, keep a record of make, and serial number for follow-up purposes.

Ventilation: Venting systems must be fully operating before starting up spray booths, ovens, or processes that produce dust or toxic fumes.

Maintenance tools: Small hand tools are priceless. Find and rehabilitate every one you can. You probably will not be able to buy them. Ordinarily, most portable power tools are not worth the cost of recovery. But you may have to repair them because new ones will be so hard to obtain.

Safety rules: Make sure power supply is off. Don't assume the utility will check with you before restoring power. Check that breakers and other important contacts are not mechanically blocked. Do not allow any worker to overexpose himself to fumes. Use gas masks if available. Exercise extreme caution in putting all loads back on the line. Keep both quenching and non-conducting fire extinguishers handy as each new load section is re-energized.

Cleaning: As soon as debris has been cleared, a hose and clean water should be used to remove dirt, oil and grease from electrical equipment. Avoid striking exposed insulation with streams of water at pressures above 25 psi. A gentle stream of water, with a cloth or fiber brush, is effective in cleaning the exposed conductors, stators and rotor bars.

Checking insulation: Use an insulation-resistance meter to determine the condition of insulation. A 500- or 1000-volt instrument is particularly suitable. Do not use a 2000-volt meter for testing low-voltage apparatus. A voltmeter for measuring drop across individual field coils is required for d-c equipment.

Drying: A temporary drying oven may be made of bricks, concrete blocks, or panels of heat-insulating material secured to wooden frames. Sheet metal, wood lined with asbestos, even all-wood boxes have been used for emergency drying of electrical equipment. Ovens must be ventilated to provide circulation and remove moisture.

Much ingenuity can be exercised in devising ways of applying heat. Steam coils, electric resistance heaters, gasoline torches applied through screens, have all been used successfully. A portable gasoline-engine-driven arc-welding set can be utilized to supply low-voltage current for internal heating, and the exhaust, piped into a drum, used for external heating. Any commercial oil burner can also be used.

Second half of the manual gives recommended procedure for reclaiming high-priority electrical equipment. These recommendations are based on the experience gained in recent years through actual disaster operations. Procedures are given for steam turbine generators, exciters, induction motors, synchronous motors, cables and conduit, transformers, meters, circuit breakers, relays, switchboard panels, metal-clad equipment, switch houses, cubicles and trucks, induction voltage regulators and lightning arresters. Here, as examples, are the sections on induction motors and generators and exciters.

Induction Motors: Wound-rotor motors can be dried by short-circuiting and blocking the rotor, and applying 20 to 25 per cent voltage to the stator windings. Adjust voltage to achieve temperature of about 90 C in stator and rotor windings, and move rotor occasionally to drain water pockets. With a large number of squirrel-cage motors of similar size and voltage, connect five in series, single phase at line voltage, but hold temperature of windings under 90 C. Turn rotors by hand occasionally. Twenty per cent voltage may be applied to large motors.

Generators and Exciters: Commutators usually give most trouble because water is sucked under the bars and cannot be driven out except by external heat. On small armatures, remove outside clamping bolts and force hot air under bars. Never apply flame direct to commutator, or use air over 100 C, or get the commutator above 100 C, because the mica sticker might soften. There are no short cuts in commutator drying, and a large machine may take 10 to 12 days or longer.

The manuals referred to in this article are: Floods and Your Electrical Equipment (25E8533), published by Allis-Chalmers Mfg. Co., Milwaukee 1, Wis. When Disaster Strikes, by General Electric Co., Section GEA-6484, Schenectady 5, N. Y. Maintenance Hints, by Westinghouse Electric Corporation, East Pittsburgh, Pa.

What You Should Know About Germanium Rectifiers

Fig. 1 (Right) Unmounted germanium cells compared for size with paper clip

Many engineers, accustomed to copper oxide and selenium rectifiers, are less familiar with the remarkable properties of germanium rectifiers. Here are the main characteristics of this important new rectifier

By W. L. OVERSTREET*

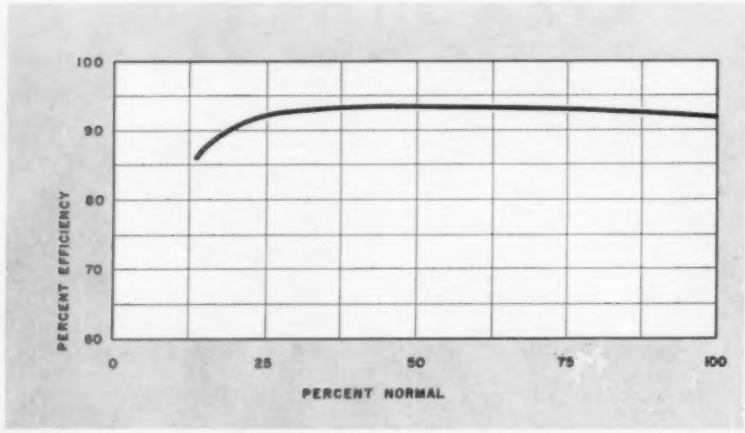


Fig. 2. Efficiency curve of a 24-v, 6000-amp d-c germanium power conversion unit

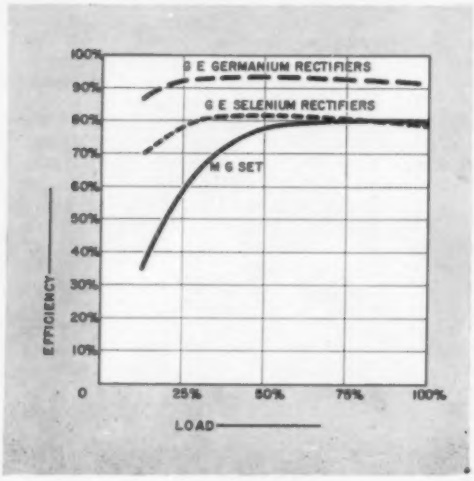


Fig. 3. (Left) Efficiency curves compared for 24-v, 5000 amp anodizing operation for m-g set, selenium, and germanium rectifier cells

GERMANIUM RECTIFIERS have given industry a long needed major step forward in d-c equipment. The little dime-sized germanium rectifier cell, shown in Fig. 1, was announced several years ago, and created quite a stir in industry when an enthusiastic newspaper man stated that six of these little rectifiers would supply all the power requirements of the average sized home.

For some time after its announcement, many misconceptions were evident about what this little rectifier could do. Claims were made that locomotives could be operated from a germanium rectifier the size of your head, and that a little black box in your cellar would furnish all your power free of charge. In any event, a great deal of interest was stirred up and a great many people went to work to find out just what this fantastic new rectifier would do.

Basically, it has been learned that under best conditions the germanium rectifier is far superior in most respects to any other means of rectification. Germanium rectifier conversion efficiencies of around 99 per cent enable the manufacturer of rectifier equipment to build a complete piece of equipment including control, transformer, and germanium rectifiers to offer the user a conversion efficiency from his a-c feed line to his d-c load of as high as 95 per cent. Figure 2 shows a typical efficiency curve of a well designed germanium rectifier. Note that the germanium rectifier efficiency remains relatively constant from full load down to less than 25 per cent load. Figure 3 gives a typical comparison between germanium rectifiers, selenium rectifiers and motor-

*District Rectifier Specialist, General Electric Co, Chicago

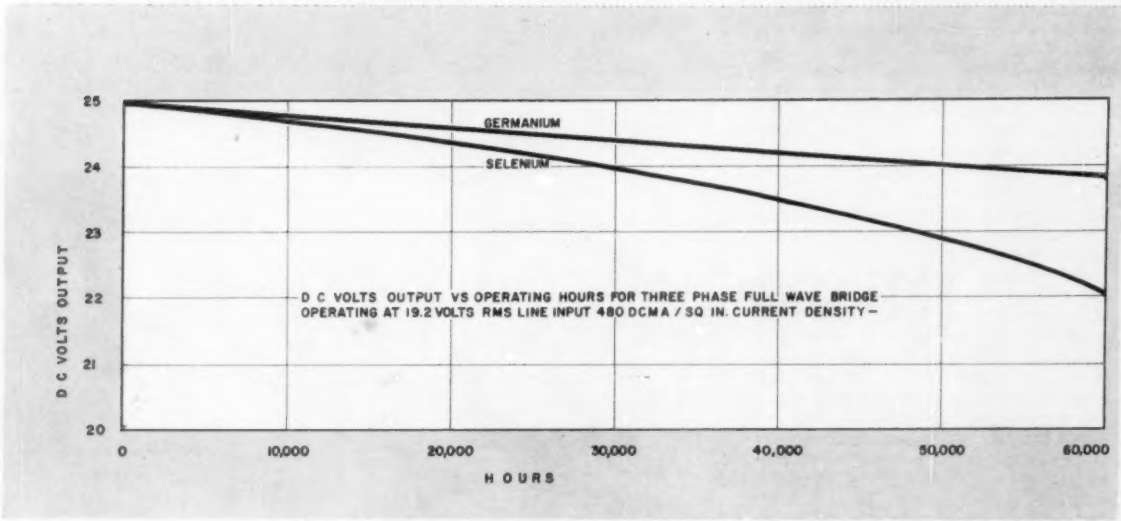


Fig. 4. Curves showing d-c volts output vs operating hours for a full wave bridge rectifier operating with a line input of 19.2 v RMS, and current density of 480 ma, dc, per sq in.

Fig. 5. Germanium power rectifiers—ratings from 0.4 to 75 amp. Below; open tray containing germanium fin assemblies

generator sets, three of the most popular means of power conversion at d-c voltages of 250 and below. As can be determined from these efficiency curves, it is not uncommon for the power conversion equipment user to be able to show enough power savings in 5 to 10 years by using the well designed germanium rectifier to pay for his initial investment in the equipment.

Figure 4 shows a record of actual life test data on germanium rectifiers for more than 4 years. Superimposed on the germanium life test data is a curve showing life test data on a selenium rectifier. Note the trend of decreased d-c output over the same period of time for germanium rectifiers. Here lies one of the most important advantages of a germanium rectifier. Germanium does not display the characteristic known as aging in the rectifier industry.

From all tests known, all actual installations in operation, and from physicists' predictions, a germanium rectifier, when operated within its rating, will continue to produce a constant d-c output with constant a-c input for an indefinite time. This, of course, means more money in the user's pocket, because, unlike the best selenium or copper oxide rectifiers on the market, a complete replacement of all rectifying elements at the end of about 6 or 8 years should not be necessary with a germanium rectifier. This fact, of course, assures the user that the initial high efficiency of his equipment will not decrease with age.

Installation of a germanium rectifier is much simpler and less expensive than a motor-generator set. A floor capable of holding the dead weight of the rectifier is all that is

required and the actual installation can be accomplished in a relatively short time by any ordinary shop electrician. The lack of rotating or moving parts, except for fans and coolant pumps, makes the need for maintenance a minor problem. The simple preventive maintenance operation of oiling fans occasionally and visually inspecting the rectifier should assure the user long continuous operation without major maintenance operations.

At present, the major portion of the several thousand kw of installed and operating germanium rectifiers is in a rating range of 80 v dc and less, and 5000 amp dc and more. It is within these rating ranges that germanium is most economically advantageous at the present stage of development. The germanium cell, at present, is a 65 v RMS rated cell which, in a 3-phase bridge rectifier with 65 v a-c input, will furnish around 80 v d-c output. In the past, in large power ratings, the use of germanium cells in series to give higher voltages has presented problems which have been expensive to overcome. However, much work has been done and germanium power supplies of 250 v and more appear to be economically possible and should be available within the coming year. This is a development hope for those applications requiring higher voltages where users wish to take advantage of the many outstanding features of germanium.

Cooling Methods

At present the most common method of cooling the germanium makes use of the germanium cell mounted on cooling fins as indicated in Fig. 5. This assembly is grouped together in numbers necessary to furnish the necessary rating. Each cell will furnish about 83 amp when properly cooled. A group of these fin assemblies are then assembled in a tray as shown in Fig. 5. This tray is then filled with a suitable coolant and sealed. In the equipment a heat exchanger, pump, and reservoir are added which makes up the complete coolant cycle. Figure 6 shows this cooling apparatus. Water is then circulated through the heat exchanger to carry off heat. Here lies another big advantage of germanium rectifiers. All heat losses of germanium cells are carried off by the user's circulating water instead of being dissipated in the room.

Big Future for Germanium

Quite frequently, when rectifier heat losses are dissipated into the room, some means of air conditioning may become necessary. This water cooling system will generally avoid such a requirement. Over 13,000 kw of germanium rectifiers in 23 installations are at present performing such operations as plating, electrolytic cleaning, anodizing, electro-chemical operations, and gas manufacturing. Figure 7 shows a typical installation in Louisville, Ky., which supplies 24 v dc at 42,000 amp for anodizing. This installation consists of 7 rectifier cubicles each of which furnishes 24 v dc at 6000 amp. Another 12,000 kw are already scheduled for installation in 1956 with far more to come. The years of testing, experimenting, and development have finally brought the fantastic little germanium to the threshold of its rightful place in industry. The industrial manager who must decide the type of equipment to purchase for his d-c requirements would do well to take note of the installations of germanium rectifiers piling up satisfactory hours of service and the many big advantages a germanium rectifier offers.

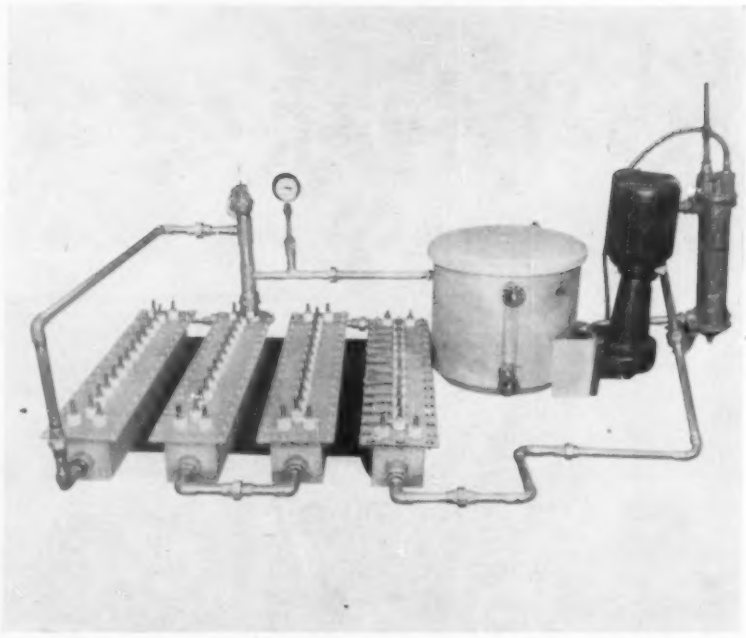


Fig. 6. Germanium test model used to get data for circulating coolant system

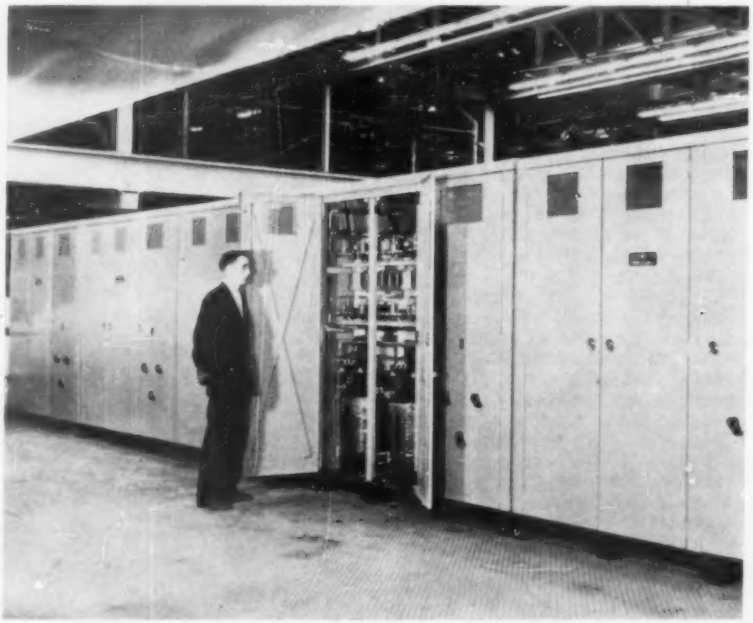


Fig. 7. Front view of a typical large germanium rectifier installation at Louisville, Ky. Input is 638 v, ac, 3-phase, 60 cycle. Output is 24 v, dc, 42,000 amp dc

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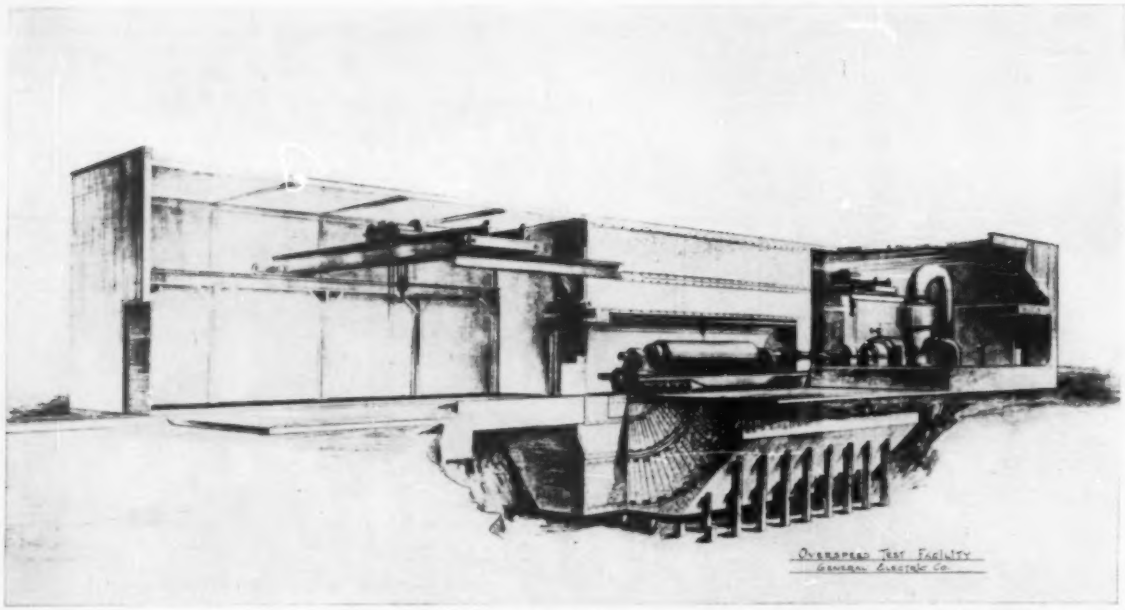


Architect's drawing of the new overspeed test facility to be built at Schenectady

G-E Rededicates Monument to Courage

World's first 5000-kw turbine generating unit moved to site in front of General Electric's new Turbine-Generator Development Laboratory

ON OCTOBER 25 the General Electric Company staged an interesting ceremony to rededicate the first 5000-kw vertical steam turbine generator unit which originally was installed in the Fisk Station of the Commonwealth Edison Co. in Chicago. In 1903, when this historic machine was placed in operation, it was the world's most powerful electric power generating machine.

The construction of this machine was a radical departure from the old reciprocating steam engine in universal use at the time, and its construction and purchase by the Commonwealth Edison Co involved considerable courage and foresight on the part of both the manufacturer and the purchaser. Its conception was due to Charles G. Curtis — he approached the General Electric Co with plans for a steam turbine as early as 1897.

E. W. Rice, who was then technical superintendant of G-E, was interested and believed it would work. He put William Leroy Emmet on the project and after building two smaller machines of 500 and 1500-kw respectively, they were ready to build the 5000 kw unit.

At that time, around 1901, the Commonwealth Edison Co in Chicago was building its Fisk Station, and Samuel Insul who was the president of that company, was interested in the proposed machine. He convinced his board of directors of his faith in the project, and as a result the unit was installed in the Fisk Station in the spring of 1903. Small as the unit appears today compared with the 450,000-kw machine now on order, it was a daring undertaking because there was some doubt that the machine would work even among some persons at General Electric Co.

But it worked very well and after only six years of reliable service, the unit was retired and replaced by a machine twice as powerful. Because of its historic interest the old machine was returned to Schenectady in 1909 and erected on *Works Avenue* as a permanent monument to the skill and engineering genius of the men who built it.

With the building of the new steam turbine generator factory at Schenectady and the completion of the Turbine-Generator Development Laboratory in recent years, it appeared appropriate to move the old machine to more modern surroundings, and so, last summer it was dismantled and re-erected on a site directly in front of the new G-E Turbine-Generator Development Laboratory. It was to mark this event that the ceremonies on October 25 were held. Returning for the occasion were C. H. Lang, retired G-E vice president of Public Relations and H. A. Winnie, retired vice president in charge of engineering services who gave the principal rededication addresses. Representing the Commonwealth Edison was Murry Joslin. Present also were prominent engineers of electric utility companies.

The Turbine-Generator Development Laboratory: Of particular importance to the visitors was the opportunity to inspect the new Turbine-Generator Development Laboratory. The purpose of this laboratory is to carry on development work in both high and low pressure steam turbines and to test large electric generator components. Present equipment includes a full-size low pressure section of a large steam turbine and also a high pressure element. These are separate units, supplied with steam from the G-E power plant and cooling water from the Mohawk River.

Equipped with elaborate measuring instruments, these test units are being used to investigate all the complex problems encountered in the design and construction of ever larger generating units. This work involves the investigation and testing of new methods of cooling generators, studies of the performance of bearings, fans, hydrogen seals, oil pumps,

Instruments for Load Analysis

2 New Ranges for General Electric Inkless Recorder Help You Get More Accurate Checks of Electrical Loads

FOR IMPROVED LOAD ANALYSIS, General Electric's CF-7 hook-on recorder now has a total of nine ranges, greatly increasing the flexibility of this already versatile inkless recorder. Easy and accurate recordings can now be made over ranges of 15/30/75/150/300/750 amperes a.c. and 150/300/750 volts a.c. making the instrument suitable for a wide variety of applications.

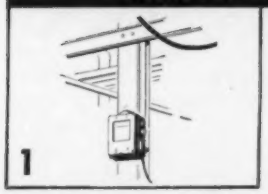
SIMPLE TO USE, the CF-7 measures either current or voltage without interrupting service. The current transformer is merely hooked onto the line. Molded in butyl, the hook-on transformer is ASA rated up to 8700 volts. For operating safety, the transformer secondary is short-circuit protected.

LIGHTWEIGHT AND PORTABLE, the CF-7 can be installed for recording either current or voltage in only four simple steps. (See explanation below.) Once installed, the recorder requires little servicing other than replacing record rolls.

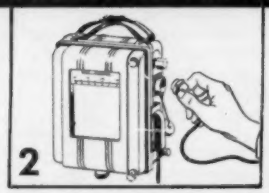
3 WAYS BETTER for checking growing commercial and industrial loads, the CF-7 provides fast, convenient hook-on installation, inkless recording, plus the ability to operate continuously for 30 days without attendance.

SEE FOR YOURSELF how the General Electric hook-on recorder can help solve coming electrical load problems. Write Section 582-16, General Electric Co., Schenectady 5, N. Y., and ask for bulletin GEA-6104, or contact your nearest G-E Apparatus Sales Office.

FOUR-STEP INSTALLATION IS FAST AND EASY—FOR RECORDING CURRENT . . .

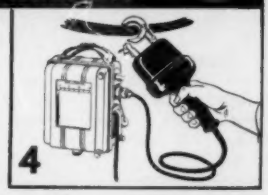


MOUNT RECORDER on pole or other convenient location. Connect recorder to either 120- or 240-volt power supply (50 or 60 cycles).



CONNECT TRANSFORMER LEAD to special socket on the side of the recorder. Extension leads are available in 10- and 50-foot lengths.

SELECT PROPER RANGE by setting selector switch on the side of the recorder for any one of six current ranges—15, 30, 75, 150, 300, 750 amperes.



HOOK CURRENT TRANSFORMER on the conductor which is to be checked. Butyl-molded transformer is ASA rated up to 8700 volts for safety.

GENERAL ELECTRIC

For more data circle 554 on Post Card

etc., and tests on electrical conductors and their insulation.

Of particular importance is the spin test equipment by means of which small turbine components are tested to destruction by spinning them at high speeds in an evacuated pit. By means of a small air turbine, test pieces can be rotated at speeds up to 25,000 rpm. In this way the engineers are better able to determine what stress and strain various parts and metals can withstand.

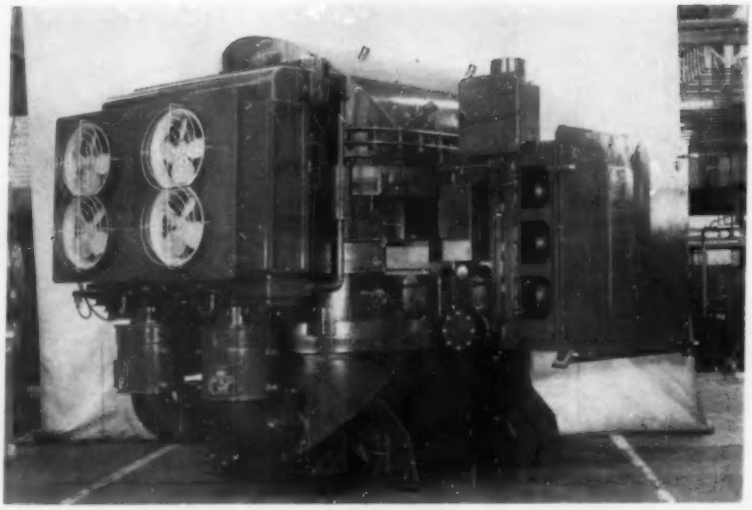
New $2,500,000 Overspeed Test Facility: The ceremonies on October 25 coincided with General Electric's announcement that it had started the construction of a new $2,500,000 Overspeed Test building as part of the Turbine-Generator Development Laboratory. The new test building will occupy some 8700 sq ft of space and will be used to spin steam turbine rotors and generator rotors — which can weigh as much as 185 tons — at speeds from 170 to 200 per cent above their normal speeds. The test facility will be used to evaluate the effects of abnormally severe operating conditions on the material properties and design features of the rotors during their performance.

In the center of the 175-ft long building will be a 57-ft long, concrete cylindrical test chamber with an inside diameter of 16 ft. The walls of the cylinder will be constructed of 14 ft of reinforced concrete. An additional 1½-in. steel plate sleeve will line the inside of the cylinder. A 5-ft thick concrete wall will seal off one end of the overspeed test chamber, while a sliding steel door 4-in. thick will cover the entrance to the chamber when a unit is being tested.

The turbine or generator rotor to be tested will be placed inside the 16-ft diameter hollow section of the test chamber. It will rest on bearing stands which are attached to a specially constructed type of railroad car which is easily moved in or out of the chamber. The rotor will be spun through breakway couplings and gears attached to a 5000-hp turbine. A 1500-hp breaking turbine will be used for deceleration purposes. During operations, the personnel of the test facility will be shielded in one corner of the drive-turbine room by a concrete wall one foot thick, this being in addition to the 5-ft thick wall closing off the test cylinder from the drive-turbine room. A closed circuit television system will provide the operators with a view of the interior of test cylinder during tests.

WOULD YOU LIKE TEAR SHEETS?

Readers wanting tear sheets of any article appearing in the issue for their personal file may obtain them by indicating the item desired on one of the post cards appearing in this issue—Editors.



This gas-insulated power transformer, believed to be world's first, was shipped from G-E's Pittsfield, Mass. plant. Sulphur-hexafluoride gas at 15 lb psi, 25 C, is pumped through transformer and fan-cooled radiator (left). High voltage terminals are at right, low voltage terminals on opposite side of welded steel tank

Gas-Filled Transformers Have Many Advantages

A 2000 kva transformer, insulated and cooled by gas instead of oil, was recently installed by Consolidated Edison Co for use in New York City. The transformer reduces power from 69,000 v to 480 v for consumer distribution.

The gas used is sulfur-hexafluoride, a compound of sulfur and fluorine with the chemical formula SF_6. Readers of POWER ENGINEERING may remember that this interesting gas was mentioned on page 80 of our November 1956 issue in connection with its application to high voltage switchgear. Its electron-poor qualities enable it to quench an arc very rapidly by absorbing arc electrons.

Sulfur-hexafluoride is a stable, nontoxic and non-inflammable gas, with excellent electrical insulating and heat transfer properties. It is sealed in the transformer at a pressure of about 30 psi, and transfers heat from the core and coils to the outside air through fan-cooled radiators mounted on the side of the transformer.

General Electric Co, the manufacturers of this Con Edison transformer, claim the following advantages for this gas insulation:

1. Lighter weight. A 10,000 kva transformer would weigh about 2000 lb less than an equivalent oil-filled unit.

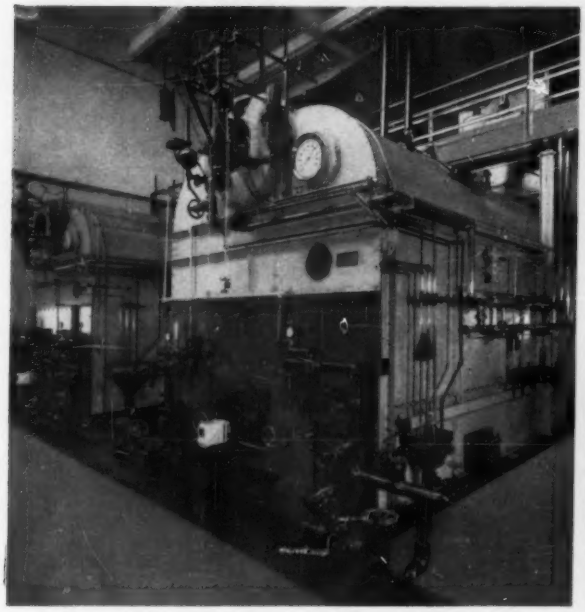
2. Greater safety. Not only is the gas non-inflammable, but since it is compressible, a fault inside the tank is less likely to cause bursting of the tank. Up to now, dry-type transformers for indoor use have been limited to about 15,000 v. Gas insulation makes possible dry-type transformers for higher voltages.

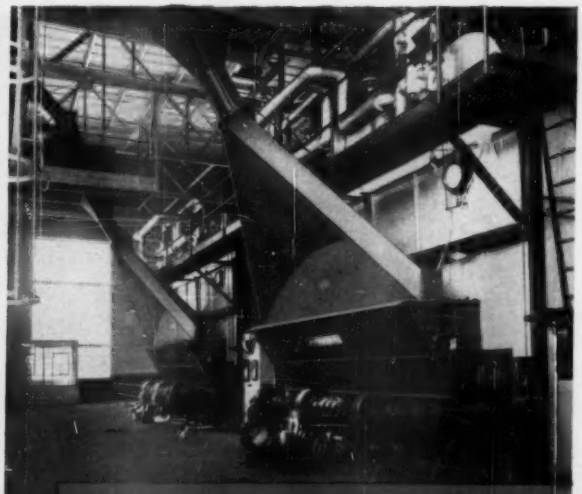
3. Quieter operation. Gas, with its low density and compressibility, does not transmit sound as well as oil, so gas-filled transformers will generally be quieter than oil-filled. This advantage will be even more marked at high ratings, since large oil-filled transformers usually have pumps which add to the total noise level.

"The man we need for this job should be worth twice what you're asking . . ."

KEELER "CP" ALL-PURPOSE BOILER

continues to deliver more steam capacity in a given space . . . larger combustion chamber with less head room than other types





Left above—Two oil fired Keeler "CP" boilers, each with 16,500-lb. steam capacity. Right above—Two Keeler "CP" boilers, each with 60,000-lb. steam capacity, operating with multiple retort bituminous coal stokers.

In thousands of operations throughout the nation and abroad, the Keeler "CP" continues to be the "pacesetter" in providing a reliable, efficient source of low cost steam for power, process and heat requirements—with user reports like these . . .

"fuel savings of approximately $700 per month" . . ."reduction of 25% over cost of operating previous boilers"..."operating almost continuously at 200% to 250% of rating and maintenance has been practically nothing"!

The Keeler "CP" is a fully steel encased and insulated water tube steam generator with water cooled walls. Among its many features, the "CP" water circulation occurs in a free and unrestricted flow, without the use of internal baffle plates. This permits operation at high overloads with exceptionally dry steam and no disturbance of the water level. The "CP" is readily convertible to all methods of firing, for all types of fuels—coal, oil, natural gas or waste gas.

Keeler boiler efficiency and dependability is available in a size unit required for your service . . . write or phone for complete information.

KEELER Type CP

READILY CONVERTIBLE

Original of its type, the "CP" delivers high efficiency with induced or natural draft operation—designed for all types of fuel and readily convertible at minimum cost. Made in a wide range of sizes in pressures to 500 psi and capacities to 150,000-lbs. of steam per hour. Shipped shop assembled up to and including 350 rated horsepower.

The Seal of Quality in Water Tube Boilers

— ESTABLISHED 1864 —

Write For Bulletins

No. F-14: Type CP Package Boilers
No. M-2A: Type CPM Package Boilers
No. DK-1: Type DK Package Boilers
No. MK-1: Type MK Boilers

KEELER WATER TUBE *Boilers*

E. KEELER CO.

100–200 West St. • WILLIAMSPORT, PA.

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Check Your Accessories for Steam Pressure Regulation

ACCESSORY can be a dangerous word. An accessory is a piece of equipment that is not regarded as an integral part of the main unit it serves. We often think of an accessory as non-essential. Sometimes it is, but often it isn't. Omitting an accessory can be expensive. Properly selected and installed accessories protect the principal regulating valve and insure satisfactory operation. Maintenance and repairs are easier.

Some of the accessories for a steam pressure regulator station are not regarded as essential. Others are omitted, usually, because of an oversight. This oversight will almost always cause trouble later on but, once the regulator station has been set up, it is usually difficult and sometimes impossible to add an accessory that was left out of original plans. The sensible precaution is to prepare a check list of vital accessories. Requirements vary, of course, but these suggestions by engineers of the Spence Engineering Company, Inc. will provide you with a basic foundation for a check list of your own.

1. By-pass valve: This is probably the most obvious accessory and the least likely to be omitted. Without a by-pass, of course, a failure of the regulator can force a complete shutdown of the system.

2. Gage for incoming steam pressure: If the valve fails to deliver the required pressure, the operator has no way of learning whether the trouble is in the valve or in the piping unless his system is fitted with a gage ahead of the valve. This will permit him to determine what pressure loss has been sustained through the piping.

3. Drip and trap: Here inlet (as at the outlet) water may collect at low loads. As the load increases, the accumulation is picked up and could cause water-hammer thrown with considerable violence. That, of course, is obviously bad. Note here, as in the other drip and trap, a dirt leg is placed below the trap take-off. This serves a dual purpose. It prevents dirt from plugging the trap and causing water to back up. Also, if slugs of water are sometimes a problem, a reservoir of this type will take up surges (like a surge tank) and permit a smaller trap.

4. Strainer: Even a normally-closed regulator can not close if there is an obstruction between the seat and the disk. The proper strainer will retain almost all foreign matter too large to pass through the regulator. Note that the strainer can be isolated with the regulator for disassembly and cleaning of the screen while the process is fed through the by-pass.

5. Stop valve on outlet side and valve on control pipe: Without these valves you cannot work on the regulator even if by-pass and inlet stop valves are included.

fold along this line—outside edges toward you

6. Pressure gage in pilot control pipe: Steam pressure on the delivery side is regulated by the pilot of the main valve. This pilot, in turn, throttles or opens according to the pressure in its control pipe which is attached to the delivery piping. Frequently the delivery pressure gage is installed in the delivery piping itself and in some cases at points quite distant from the main valve. But it is preferable that the delivery pressure gage should indicate the pressure that is actually affecting the pilot. If it is necessary to know the pressure at some point remote from the regulator, a second gage may be installed.

Don't forget the accessories after installation. The by-pass and shut-off valves should be operated frequently to be sure they are not "frozen" when any emergency occurs. Clean out the strainer frequently. Remove accumulated foreign matter. Note that the by-pass valves and piping are so arranged that should, on occasion, access to the strainer screen be necessary to remove dirt stuck tightly to it, shutting down the entire system is not required.

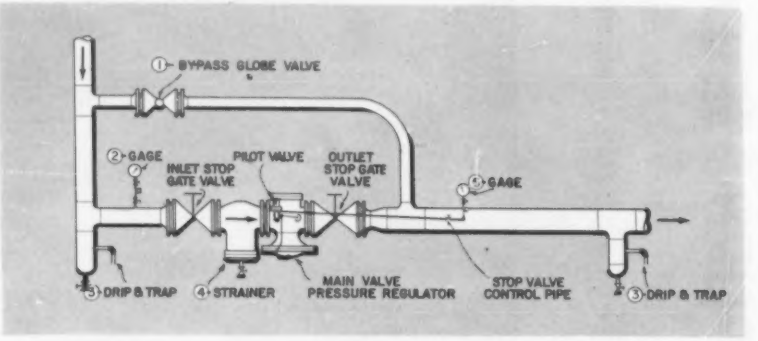


Diagram of a typical pressure regulating station showing the proper accessories correctly installed

Know What You're Doing With Twist Drills?

Here's a Refresher Course in a Nutshell

WEAR AND BREAKAGE on twist drills is reduced by using the right drill for each job, Rockwell-Delta power tool engineers point out. The standard, 118-deg point angle is adequate for most work, but faster and better production usually results when one of five common variations is used for a given job. And, say the Delta experts, the average person can easily grind drills to match requirements of specific metals and plastics if he knows the fundamentals of a good cutting edge.

Variations in the point angle and lip clearance angle have different effects when working different materials. In general, blunt points are used on harder metals — where there is danger of tearing — and on very thin sheets. Sharper angles are more efficient when drilling plastics or soft metals.

Specifications for various special purpose twist drills are shown in Fig. 1.

How to Get Zero Rake

Grinding off the cutting edge of each lip gives a drill with zero rake. This makes the edge scrape rather than cut,

cut along this line

Clyde equipped barge handles 800 T.P.H. for Ohio's Raymond City Coal

Free digging of 700 to 800 tons per hour . . . that's the average coal handling performance of Raymond City Coal and Transportation Corp.'s Clyde equipped barge derrick.

Coal from West Virginia is shipped by barge to their modern and efficient plant at North Bend, Ohio. Here, it is loaded directly into a barge mounted hopper, then by conveyor belt to stock piles, railroad cars or to storage bins for truck loading.

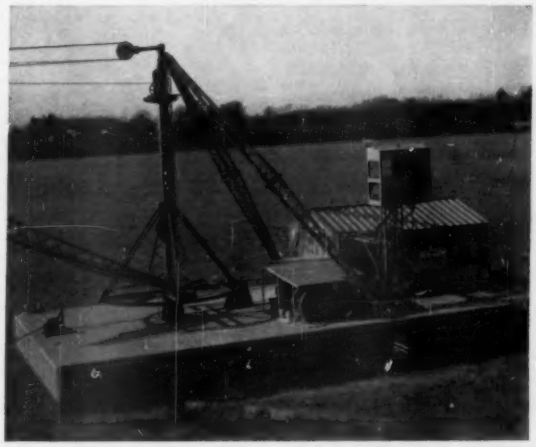
CLYDE EQUIPPED ALL THE WAY

Clyde builds a "working team" for every kind of material handling operation.

Raymond City Coal and Transportation Corp.'s coal handling barge is equipped with a heavy duty, Clyde steel derrick operated by powerful 25,000 lb. line pull hoist and independent swinger.

Two Clyde barge movers position the coal barges during unloading operations. Two Clyde capstans, one at each end of the barge, are used for mooring lines. Greater capacity, lower handling costs and an operation ". . . free from trouble since its installation . . ." expresses Raymond City's approval of this fast working, Clyde unit.

Your material handling methods can also be improved by using Clyde equipment. *Why not get all the facts on Clyde.*



Air operated Clyde hoist has control lever bank elevated to permit unobstructed vision for operator, Anti-friction bearings on drums and shafts of hoisting equipment and on derrick sheaves, assure efficient and dependable service with less maintenance.

HOISTS · DERRICKS · WHIRLEYS · BUILDERS TOWERS · CAR PULLERS · UNLOADERS · ROLLERS

CLYDE IRON WORKS, INC.
Established in 1899
DULUTH 1, MINNESOTA

A SUBSIDIARY OF BARIUM STEEL CORPORATION

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and reduces the tendency of the drill to dig into brass and other soft metals and most plastics. It's not good with plastics with low melting points, however, because heat will cause chips to gum and stick to the drill. Zero rake also produces a stronger cutting edge, making it suitable for drilling very hard steel.

Drills, like all cutting tools, require clearance behind cutting edges to permit chip removal. Variation in the clearance angles changes size and shape of chip.

Checking the Required Arc

Lip clearance angle is ground by starting with cutting lips against the wheel and then dropping the other end through an arc equal to the lip clearance angle end as the drill is rotated through one-sixth of a full turn. Easiest way to determine how much to lower the drill is to swing a new standard drill against the stationary wheel, noting how much movement is required to keep the ground surface in contact. This will indicate the arc required for a standard, 12-deg clearance angle. Other angles can be obtained by proportionate variation of the movement.

The curved face of the web should be thinned after the point is ground, in order to reduce the thrust needed to force the drill through the work. The web can be thinned easily by grinding with a flat-edge or round-edge wheel.

There are also attachments for bench grinders that permit perfect mechanical grinding of drill points to any standard angle. Where points are ground by hand, care should be taken not to burn the drill point.

Most important factor in long drill life is proper drill press speed. Most well-designed drill presses have a sufficient range of speeds for all but extremely specialized drilling. Table shows speeds recommended by Delta for metals of varying hardness and drills from 1/16-in. through 3/4-in.

Table of recommended speeds for metals of varying hardness and for drills from 1/16 in. through 3/4 in.

DRILL SPEEDS IN R.P.M.

14" High Speed
680, 1250, 2400, 4600, R.P.M.

14" Slow Speed
470, 780, 1300, 1950, R.P.M.

Diameter of Drill	Soft Metals 300 F.P.M.	Plastics and Hard Rubber 200 F.P.M.	Annealed Cast Iron 140 F.P.M.	Mild Steel 100 F.P.M.	Malleable Iron 90 F.P.M.	Hard Cast Iron 80 F.P.M.	Tool or Hard Steel 60 F.P.M.	Alloy Steel Cast Steel 40 F.P.M.
1/16 (No. 53 to 80)	18320	12217	8554	6111	5500	4889	3667	2445
3/32 (No. 42 to 52)	12212	8142	5702	4071	3666	3258	2442	1649
1/8 (No. 31 to 41)	9160	6112	4278	3056	2750	2445	1833	1222
5/32 (No. 23 to 30)	7328	4888	3420	2444	2198	1954	1465	977
3/16 (No. 13 to 22)	6106	4075	2852	2037	1833	1630	1222	815
7/32 (No. 1 to 12)	5234	3490	2444	1745	1575	1396	1047	698
1/4 (A to E)	4575	3055	2139	1527	1375	1222	917	611
9/32 (G to K)	4071	2712	1900	1356	1222	1084	814	542
5/16 (L, M, N)	3660	2445	1711	1222	1100	978	733	489
11/32 (O to R)	3330	2220	1554	1110	1000	888	666	444
3/8 (S, T, U)	3050	2037	1426	1018	917	815	611	407
13/32 (V to Z)	2818	1878	1316	939	846	752	563	376
7/16	2614	1746	1222	873	786	698	524	349
15/32	2442	1628	1140	814	732	652	488	326
1/2	2287	1528	1070	764	688	611	458	306
9/16	2035	1357	950	678	611	543	407	271
5/8	1830	1222	856	611	550	489	367	244
11/16	1665	1110	777	555	500	444	333	222
3/4	1525	1018	713	509	458	407	306	204

Figures are for High-Speed Drills. The speed of Carbon Drills should be reduced one half. Use drill speed nearest to figure given.

fold along this line—outside edges toward you

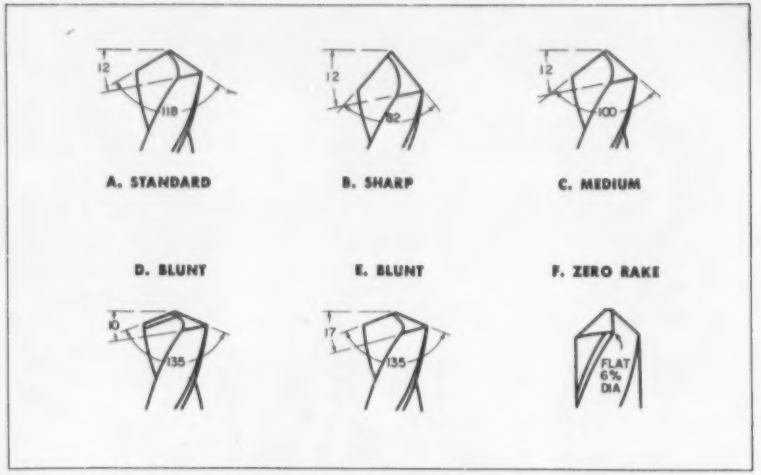

Fig. 1. Point angles and clearances for twist drill tips to give best results for various materials. A. Satisfactory for all materials—specifically for soft to medium steel. B. For wood, thermoplastics, Hi-silicon aluminum. C. Hi-silicon aluminum, hard copper, cast iron, hard rubber and fiber. D. All very hard steels. E. All soft to medium aluminum alloys. F. Soft to medium brass. Copper, most plastics. Very hard steels.

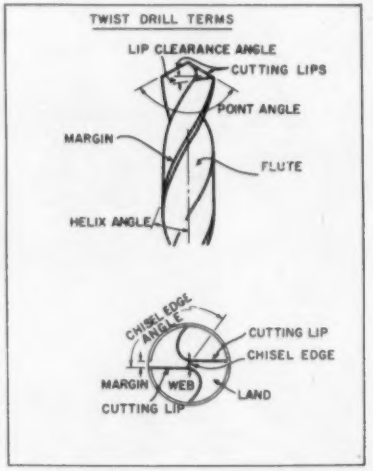

Fig. 2. Some of the most commonly used expressions for describing various parts of a twist drill bit

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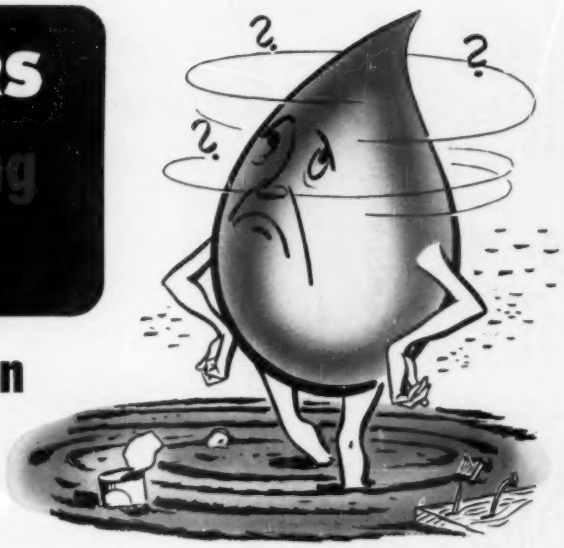
ALLIS-CHALMERS
Water Conditioning
ON THE JOB



Reporter finds solution to wide range of water problems

•Raw water is seldom suitable to meet specific requirements of the job. It usually needs some type of conditioning — best determined by a specialist. Here are typical examples of Allis-Chalmers water conditioning experience, equipment and chemicals in use.

Saved $22,000 First Year

Kansas—A chemical company plagued by high steam costs. Their boiler make-up water contained a high solids concentration, requiring a high blowdown rate.

After careful analysis of their problems, an Allis-Chalmers water conditioning engineer recommended Allis-Chalmers Anti-Foam. Use of this chemical resulted in increasing the solids concentration of the boiler water without carry-over. This, in turn, reduced the percentage of blowdown required.

Using A-C Anti-Foam, the company conservatively estimated first year savings of $22,000 in heat, water and chemicals.

* * *

Replacement of Condensate Return Lines Reduced to Practically Zero

Wisconsin—Here in one of the largest malt producing mills, several million pounds of steam are used daily for drying malt.

A special crew used to work all day every day doing nothing but replacing corroded condensate return lines. This, of course, was extremely costly.

Seven years ago, Allis-Chalmers water conditioning engineers were called in. Use of Allis-Chalmers No. 160 return line corrosion inhibitor was suggested.

Piping failures were reduced to the point where they only occur occasionally, and the maintenance crew has been assigned to other duties.

The Customer Is Always Right . . . Well, Most of the Time

East Coast — This plant had been using internal treatment of its boiler water. Chemical costs seemed excessive to management. After analyzing their own situation, they requested bids on a deionizer for treating makeup.

Instead of merely submitting a bid on the equipment specified, Allis-Chalmers engineers analyzed the water and the plant problem. This analysis showed that plant needs were such that a deionizer wasn't needed.

All that was needed was a de-alkalizer. Result: a savings of thousands of dollars.

* * *

The Case of the Dirty Dishes . . . or Don't Blame the Poor Dishwasher

Midwest — A harried plant cafeteria manager placed a frantic call to Allis-Chalmers water conditioning experts. Something was wrong. Glasses were spotty and plates had to be individually wiped off before they could be used. The grumbles were growing in the dining room . . . costs rising in the kitchen. His brand new $30,000 dishwasher wasn't getting the dishes clean, and the supplier of the dishwashing machine said the trouble was caused by the water.

The only trouble with that theory was that he had just installed a water softener the year before. The Allis-Chalmers water conditioning engineer examined the dishes coming out of the water and then asked to see the water softener. The problem was obviously hard water. The unit seemed to be in good working order and the tag indicated the softener had been recharged the previous day.

The maintenance man was called and asked to recharge the softener while an A-C engineer stood by. He went through all the steps—all but one, that is. He failed to close the bypass valve above the softener and practically none of the water went through the softener. It was then learned the operator was new and had not been properly trained.

Needless to say, the maintenance man is now an expert at operating the system, and everyone is pleased with the sparkling dishes.

Moral: A-C engineer's service covers the water front.

Expert Saves Steam for Drop Forge User

North Central — An Allis-Chalmers water conditioning engineer was called in by a manufacturer to supply water conditioning for makeup water. In checking the plant, here's what he found:

A large number of steam-operated drop forges are used by this company. The steam picked up oil from the pistons of the forge and was too contaminated for further use. It was dumped to waste.

He recommended installation of condensate oil removal filters. This was done and today practically all condensate is recovered. Makeup and water conditioning requirements are greatly reduced.

Problems Solved

For an answer to your industrial water problem, call the A-C office nearest you or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

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Two Simple Traveling Lathe Steady Rests

By F. F. Riley

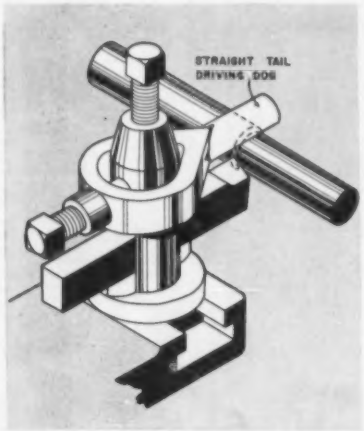


Fig. 1. This steady rest is simply a straight tail lathe driving dog clamped to the pillar-type tool post

THE TRAVELING steady rest for supporting thin shafts in the lathe during turning usually requires a good bit of effort to mount in place on the machine, and operators will often struggle with small diameter work to avoid getting the steady rest, cleaning it and fixing it in place.

Where the pillar-type of tool post is used on lathes, the idea shown in Fig. 1 can often be adopted with advantage. It is a very old idea, once used by turners in general machine shops, but it seems to have been forgotten in recent times and is worthy of revival since it offers a certain amount of support against the upward thrust of the cutting tool.

The steady rest is a straight tail lathe driving dog clamped to the pillar-type tool post, with the tail resting on the turned portion of the work. Where the lathe dog screw end might tend to slip into the tool post slot, a piece of packing was inserted under the screw end so as to bridge the slot. Once tightened in place, the lathe dog can be finely adjusted by tapping it lightly with a hammer to adjust its pressure on the work. The modern tendency to make some small lathe dogs from brass castings is an advantage, although steel lathe dogs seem to have worked well in the past without tending to tear up the work surface.

A more refined version of this type of traveling steady rest is shown in Fig. 2 and comprises a shaped piece of brass or bronze bored out to suit the diameter of the pillar-type tool post. The steady can be clamped in place on the tool post by means of a headed set screw spanning a saw-cut which intersects the mounting hole.

The steady rest can be swiveled to a suitable position on the tool post and used with the extended off-set leg at the left or the right side by turning it over. This steady is very valuable for parting-off in light lathes when using a straight or cranked shank-type parting-off tool.

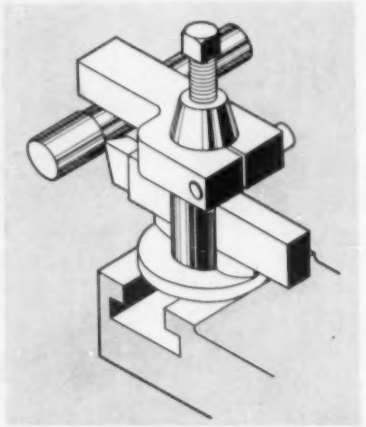


Fig. 2. Here the steady rest is a shaped piece of brass or bronze bored out to suit tool post diameter

The lower surface of the leg on the steady slides over the work as the tool is traversed inward toward the work axis. The downward pressure of the work on the parting tool tends to be transformed into a downward pull on the work itself and resists the tendency for the lathe spindle to lift.

The great advantage of both types of traveling steady rests described is the speed with which they can be mounted in position on the lathe. Unfortunately, neither of them will resist the rearward deflection of the work which is one component of the forces caused by the cutting tool.

CO_2 and Excess Air in Combustion of Lignite

By V. F. PARRY
Chief, Branch of Coal Technology,
U. S. Bureau of Mines

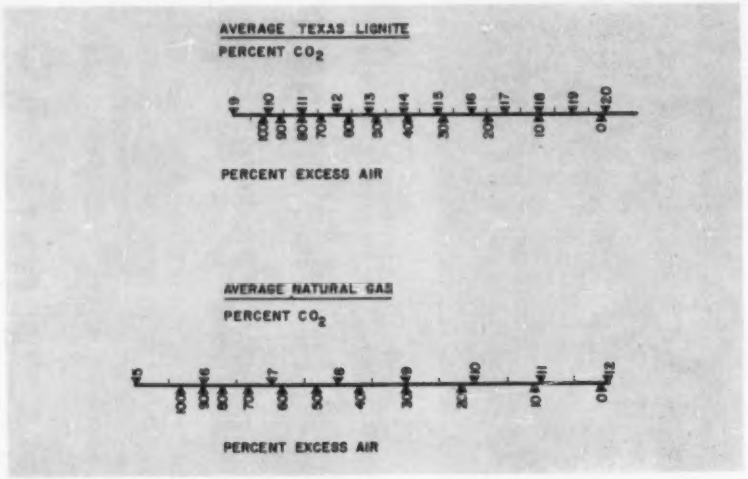
THIS USEFUL chart is based on data from the Bureau of Mines of the U. S. Department of the Interior, and applies to natural gas as well as lignite. The figures indicate the optimum practical excess air when burning lignite or average natural gas.

Due to the high oxygen content of lignite, the products of combustion are somewhat different from the products from higher rank fuels when burned with the same excess air. Lignite can be burned efficiently with 10 to 30 per cent excess air.

The following table gives the relationships when burning average Texas lignite and average natural gas.

Per cent excess air	Per cent CO_2 avg. Texas lignite	Per cent CO_2 avg. natural gas
0	19.9	11.9
10	18.0	10.7
20	16.5	9.8
30	15.2	9.0
40	14.1	8.3
50	13.2	7.7
60	12.4	7.2
70	11.6	6.7
80	11.0	6.3
90	10.4	6.0
100	9.9	5.7

Plotted on accompanying line chart.



Fold along this line—outside edges toward you

Cut along this line

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. . . low in moisture

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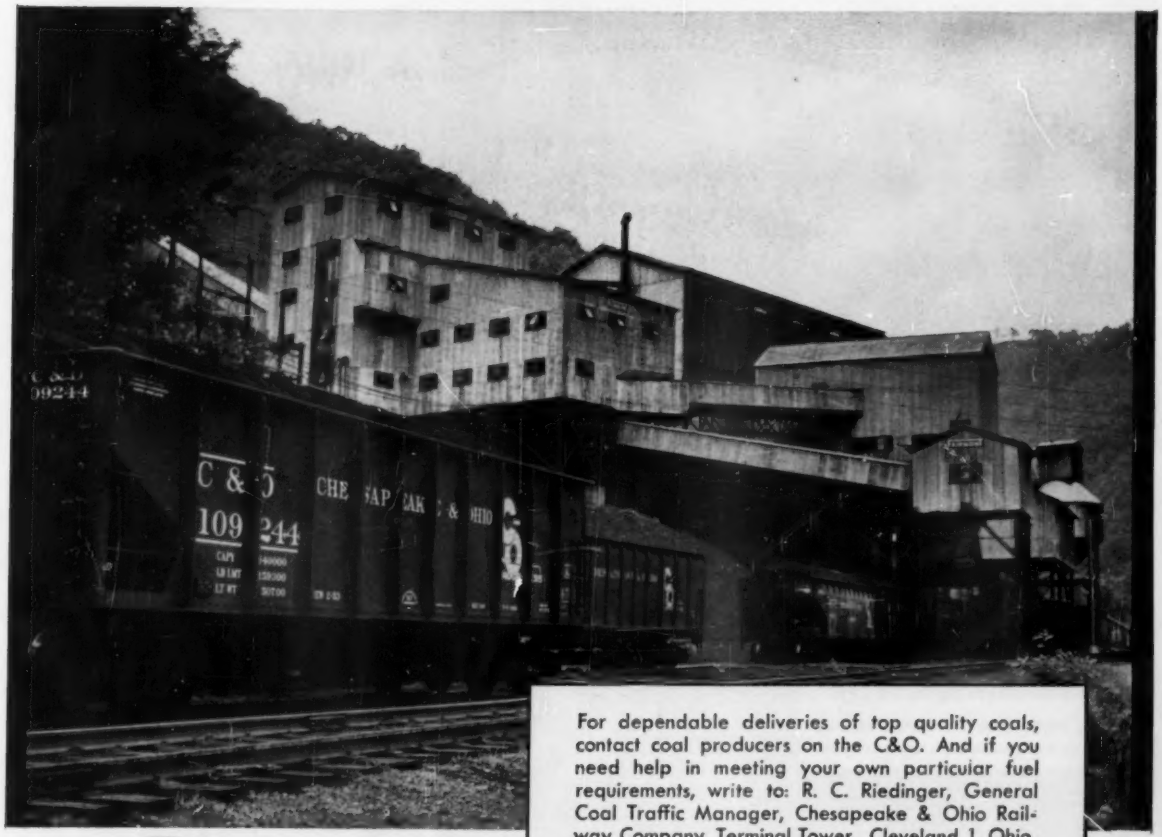

For dependable deliveries of top quality coals, contact coal producers on the C&O. And if you need help in meeting your own particular fuel requirements, write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake & Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

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Energy for Tomorrow

continued from page 101

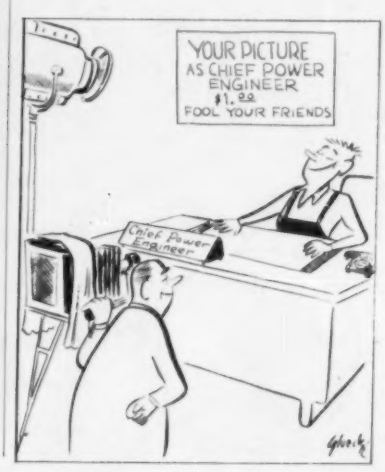
in very short supply in a world which has become dependent upon their portability and convenience.

The solid fuels will still be relatively abundant, but the energy demand will be so tremendous that even coal will be inadequate to meet the needs of an industrialized world in 2050 A.D. with 3 times today's population [2] and 20 times today's energy appetite. Figure 7 shows the range of estimates of fossil fuel reserves as made by a number of authorities. Even the most optimistic speculations are dwarfed by the cumulative demand which, by 2050, will have exceeded $100{,}000 \times 10^{15}$ Btu.

Nuclear energy, relatively slow to get a commercial start in the United States will have to become a major factor after 1975. Sporn [7] predicts that the coal-equivalent of atomic energy will be only 15,000,000 tons in 1965 and 52,000,000 in 1975. Ayres [8] points out that if all our present electric power were generated by nuclear reactors, only 12 per cent of our fossil fuel would be saved. After 2000 A.D., nuclear power will have to dominate our utility system because the domestic heating load will then have to be met by electricity and solar energy.

In other parts of the world, where the fossil fuels are scarce and hence expensive, nuclear power will undoubtedly arrive more rapidly than in the U. S. When the break-through occurs which obviates the necessity for generating electricity from nuclear energy by means of heat-engines, far wider and more rapid adoption of atomic power may be expected.

Reserves of atomic energy in the form of fissionable materials are extremely large by today's standards. Putnam estimates [3] that all of the world's fossil fuel reserves may total $27{,}000 \times 10^{15}$ Btu, while nuclear



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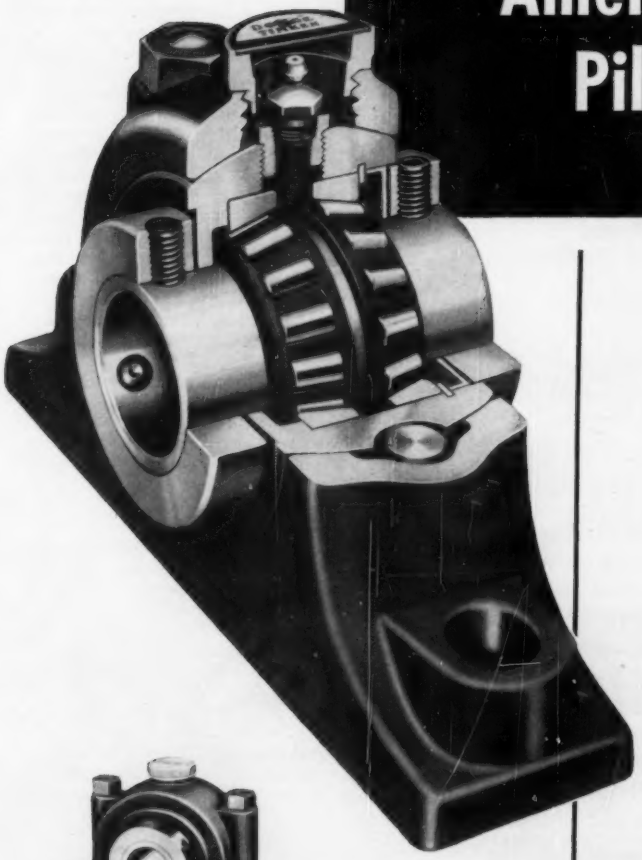

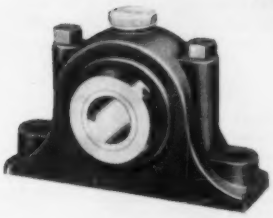

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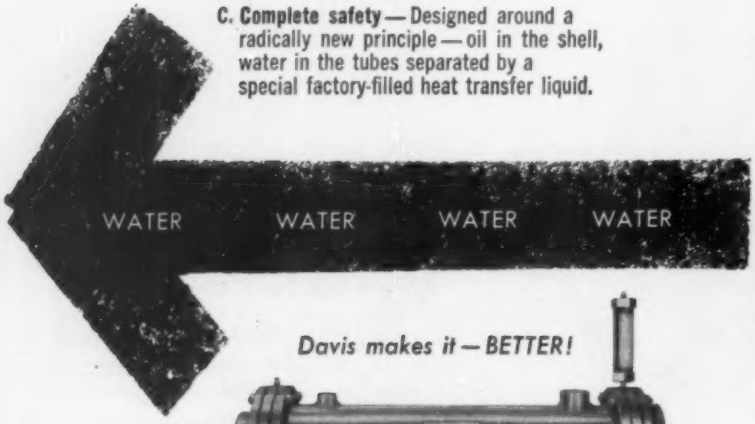

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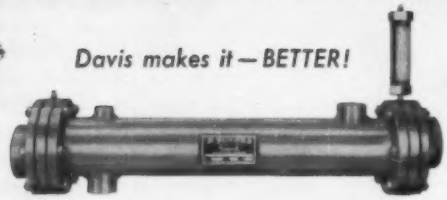

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Energy for Tomorrow

continued from page 126

fuels may total $575{,}000 \times 10^{15}$ Btu. This estimate is based on the assumptions that breeder-reactors will be used with a net burn-up of one-third of the fuel and that costs twice 1950's are permissible.

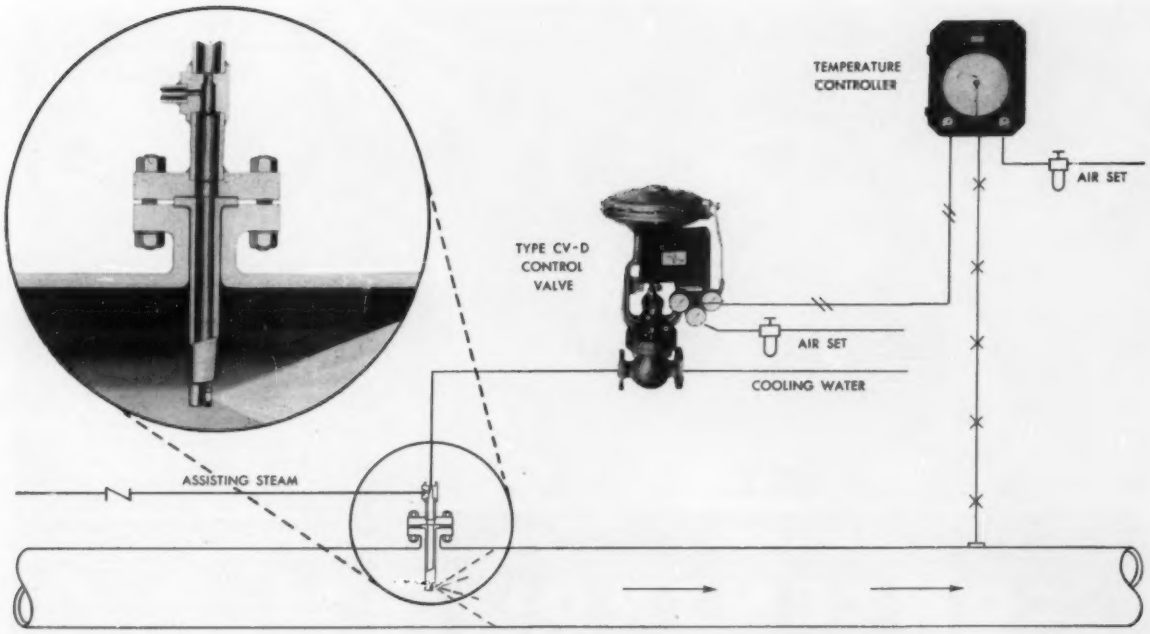
The development of a really satisfactory means of energy storage is a vital necessity if we are to retain the mobility which automobiles and airplanes have taught us to expect. When some radically new storage device is found, we can apply it to a myriad of uses, from running automobiles to storing solar energy.

Nuclear fission is not an endless asset in our capital fuel account, because there is a large but not unlimited amount of uranium and thorium buried in the earth. The fusion process which unites nuclei of hydrogen isotopes to form helium atoms would be essentially a perpetual energy source on earth as it is in the sun, because the seas around us are endless reservoirs of hydrogen. No way is now known to contain the fantastic temperatures (100,000,000 K) at which the fusion reaction proceeds, but in theory, at least, an intense magnetic field could do the job. The ingenuity which produced the destructiveness of the hydrogen bomb is now being turned to the constructive task of harnessing the fusion process [12]. No prudent prophet would say that it cannot be done.

Solar Energy

The only endless energy asset which the earth possesses is solar radiation. The sun, some 93,000,000 miles away, radiates into surrounding space about 12×10^{26} Btu every *second*. Something like 53×10^{20} Btu per year reaches the earth's atmosphere. Allowing about 40 per cent for reflection and absorption in the air, dust and water vapor which surround the earth, about 32×10^{20} Btu [3] reach the world's surface. Of this, 75 per cent falls upon the seas,

"No, this isn't the county jail—but you're close!"



Normal installation of a Copes-Vulcan Steam-Assist Desuperheater is shown schematically

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Continued from page 128

leaving about 8.4×10^{20} Btu to warm the lands and to do all of the indispensable jobs which we now take for granted.

Solar energy which reaches the surface of the United States is about $50{,}000 \times 10^{16}$ Btu per year, or more than 1000 times today's annual energy demands. Unfortunately, vastly more ingenuity will have to be exercised before we are able to utilize even a fraction of one per cent of the available solar energy. The most probable starting point for the utilization of solar energy on a large scale will be the heating and cooling of homes and offices in the southern half of the United States. At the other end of the temperature scale will come the use of solar furnaces for research and production at temperatures above 3200 C. Photo-electric and photo-synthetic processes will make use of solar energy for special applications. Distillation and pumping water for drinking purposes and later for irrigation will be important uses of solar energy.

In a realistic appraisal of the part which solar radiation will play in supplementing other energy sources, it must be realized that solar energy is variable, seasonal and intermittent. The second installment in this series will discuss the availability of solar energy in the U. S. and throughout the world. The devices which have been used to harness solar radiation will then be described.

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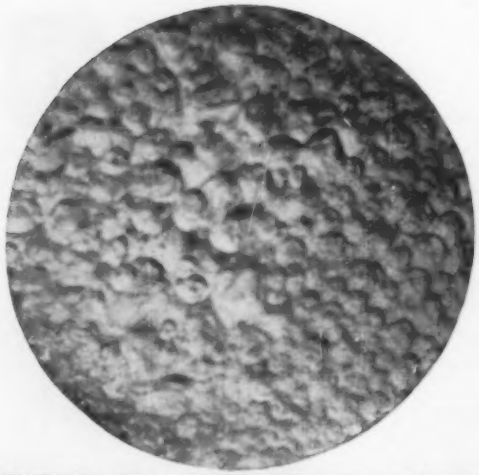

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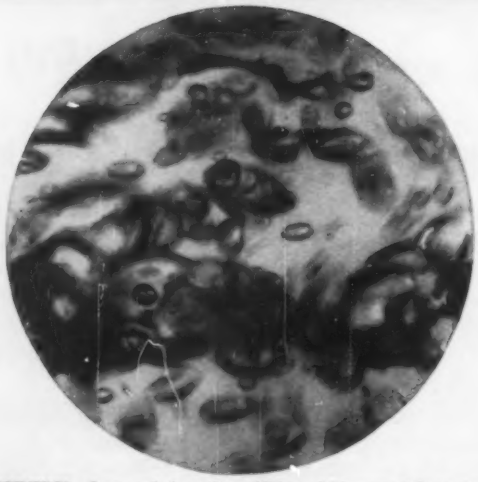

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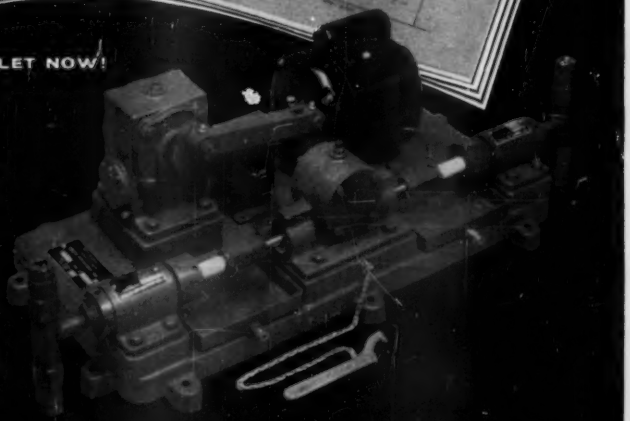

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NEW ENGINEERING BOOKS

Materials for Nuclear Power Reactors by Henry H. Hausner and Stanley V. Roboff. First Edition, 4¾ by 7 in., 224 pages, cloth. Published by Reinhold Publishing Corp., 430 Park Ave., New York, N. Y. 1955. Price $3.50.

This book was prepared because of the critical importance of reactor materials in nuclear power technology. It is intended to serve as a ready guide of reactor materials for the scientist and for the material engineer. However, the context of the book has been planned and presented in a form such that a layman with but a small technical background can learn and understand the problems and applications of materials in power reactors. Thus, the book should be valuable for those persons who have an interest in the atomic energy field, yet who are not technically trained such as investors, insurance men, lawyers, executives and students.

Within the limits of national security, the basic types of materials used in reactors are described together with their function and the problems associated with their use. Basic information concerning each of the materials is given. A chapter has been included describing the special problems encountered in reactor design and operation, due to radiation — a subject which, naturally, is of particular interest. Every effort seems to have been made throughout the text to describe technical processes, operations and events in the simplest, possible manner consistent with accuracy.

This book is one of the Reinhold Pilot book series.

★ ★ ★

Hydraulic and Pneumatic Operation of Machines by H. C. Town. Cloth binding, 192 pages including index, 6 by 9 in. Published by the Philosophical Library, 15 E. 40th St., New York 16, N. Y. Price, $7.50.

Hydraulic power normally calls to mind the hydraulic turbines of large power installations. This book, however, deals with the more diminutive branch of hydraulic power; i.e., hydraulic motors, pumps, and dowells, used in the operation and control of industrial machinery. Since there is much common ground, the book also includes similar information on pneumatic systems.

Much of the information in these fields has been available only to those with facilities for extensive research, and is to be published later. This book purports to do the job for you. Since a great deal of standard power plant equipment is operated and/or controlled by pneumatic or hydraulic power, this book may be quite helpful in extending the engineer's understanding of his control systems.

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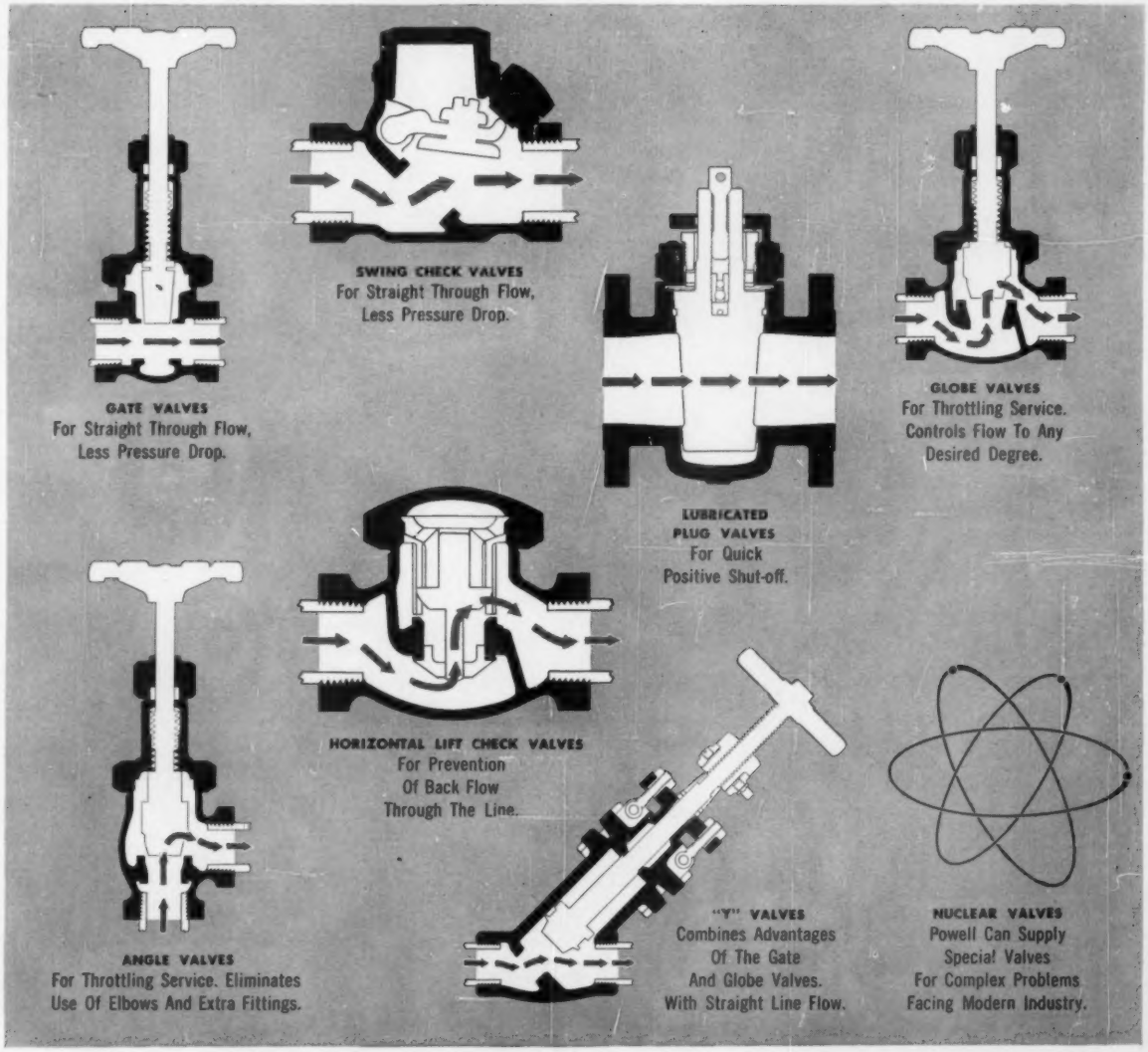

for every flow control problem there is a right Valve

Powell can supply this right valve—*made right* of the right material*. Every part of every valve must pass rigid inspection. And as a final step in manufacture, every Powell Valve has *Performance Verified* through an *actual line test.*

As an aid in selecting the right valve, the basic valve designs are illustrated here. For complete information on the wide range of sizes and materials available in each type of the basic valves illustrated above, consult your Powell Valve distributor. If none is located near you—or if you have a special flow control problem—write direct to The Wm. Powell Company, Cincinnati 22, Ohio.

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*BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES.

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All that a Water Tube Package SHOULD be

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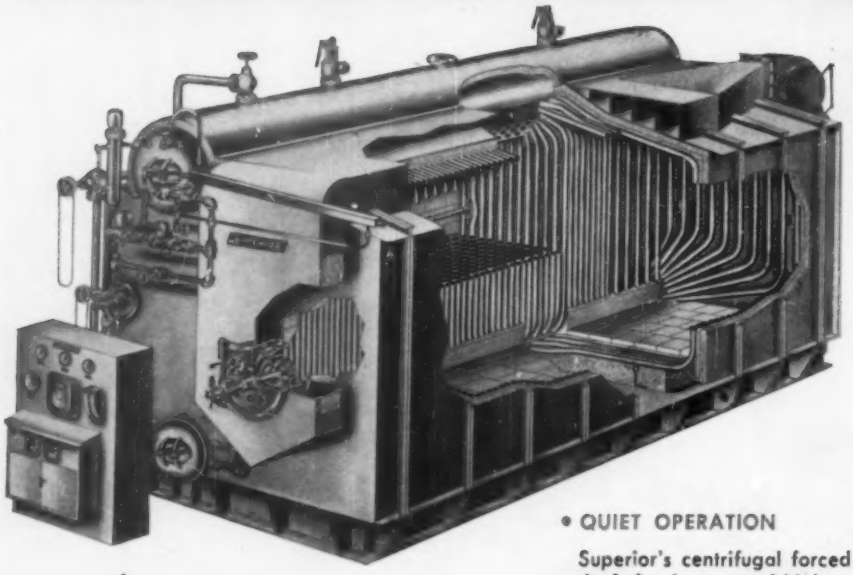
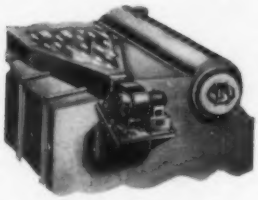
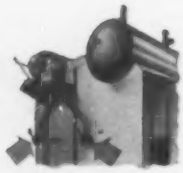




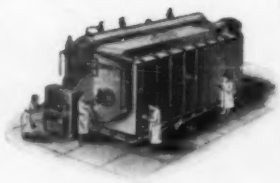
• QUIET OPERATION

Superior's centrifugal forced draft fan is mounted high at the rear of the boiler to provide quiet operation and an uncluttered firing front. Over-the-furnace air duct cools the furnace roof and provides better air distribution to the burner.



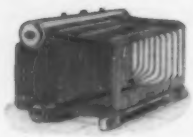
• AIR-COOLED OBSERVATION PORTS

An exclusive Superior Feature which utilizes air from the forced draft fan to provide a cooling shield at the observation ports, eliminates the danger of observing a fire in a pressurized furnace through an open port.



• FIRE TESTED

A distinct advantage of this truly packaged unit is factory fire-testing. Every Superior Steam Generator must achieve its guaranteed performance rating before shipment.



• TANGENT TUBES IN LARGE FURNACE

Released heat in the furnace is quickly absorbed in the tangent tubes, which are all riser elements providing rapid circulation and discharge directly into the steam drum.

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PUMPS

201 **Controlled Volume Pumps** — Bulletin 953, 24-pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water treating systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, and systems for waste and sanitary water treatment included. Milton Roy Co.

202 **Steam Pump Care** — Bulletin G-2280, "How to Install and Take Care of Steam Pumps," is a 24-pp booklet containing a step-by-step series of 88 illustrations showing how to increase the service life of all types of steam pumps. It offers 28 tips on proper installation of the pumps, 54 tips on care techniques. Section on installation provides information on suction, packing the pump, starting it, and trouble shooting. Section on maintenance deals with such subjects as steam valves, liquid piston and rod, piston packing, liners, gaskets and many others. Worthington Corp.

203 **Meter that Pumps** — Bulletin 300, 8 pp, describes company's improved meter that pumps — designed for precise metering and proportioning of small quantities of low viscosity fluids at low cost, over extended periods of time. Complete capacity tables and a detailed schematic are also included. Hills-McCanna Co.

VALVES, TRAPS, PIPING AND ACCESSORIES

204 **Check Valves** — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

205 **Lubricated Plug Valves** — Catalog PV-24, 36-pp, shows in detail a line of iron and steel lubricated plug valves. Many illustrations of the single, screwed and bolted gland type valves are shown, including photos, sectional and detailed drawings. Also included is physical data on dimensions. The Wm. Powell Co.

206 **General Purpose Valves** — Supplement No. 1 to Catalog F-9, 32-pp, offers complete information on company's series of general purpose drop forged steel valves, gate, globe and angle types, sizes ¼ through 2 in. Includes descriptions of each type along with drawings showing component parts. Dimensions and other

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specifications are tabulated, and a pressure-temperature ratings table is included. Henry Vogt Machine Co.

208 Valve Chart — Form 194, 24 pp, is a valve comparison chart, listing valve figure numbers of 15 major manufacturers and the OIC equivalent valve figure numbers. Compares variety of valves in ferrous and non-ferrous materials, describes different valve lines. The Ohio Injector Co.

209 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

210 Water Hammer Control — Cause, effect and control of water hammer in piping systems is the subject of 8-pp Bulletin WH 851. Photos, drawings and curves supplement text, and test data is presented to show efficiency of company's silent check valves in water hammer control. Some typical installations are illustrated. The Williams Gauge Co., Inc.

211 Pump Valves — Key features of company's line of pump valves are outlined in 6-pp Bulletin V-112. Includes cutaway view showing design features, standard materials table, and a table of standard pump valve sizes. Sims Pump Valve Co., Inc.

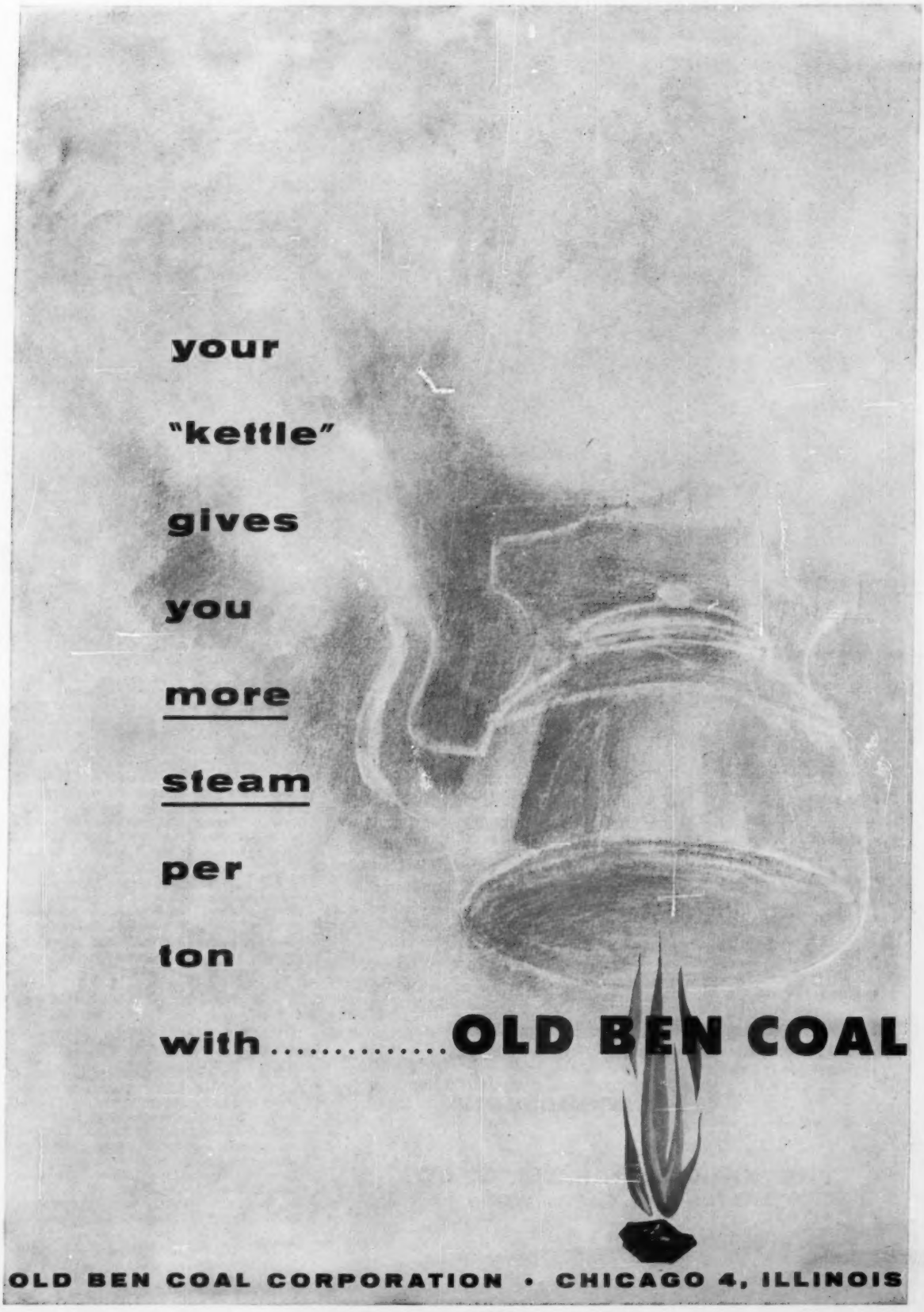
212 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are discussed and illustrated. Crane Co.

213 Steel Gate Valves — Four types of Hancock general purpose steel gate valves for process and power piping systems are described in illustrated Bulletin 202 C, 12 pp. Material specifications, dimensions given, also service pressure ratings. Manning, Maxwell & Moore, Inc.

214 Valve Data — This loose-leaf notebook contains a collection of company's bulletins on its line of valves for control of air, gas, liquids and solids. It features complete operating, design, dimensional and specification data on butterfly, slide, automatic and proportioning valves, and is profusely illustrated with photos, drawings and diagrams, highlighting valve design and construction. W. S. Rockwell Co.

215 Industrial Valves — Condensed Catalog 105, 28-pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Also included is company's Mudwonder valve for abrasive fluids. Edward Valves, Inc.

216 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball



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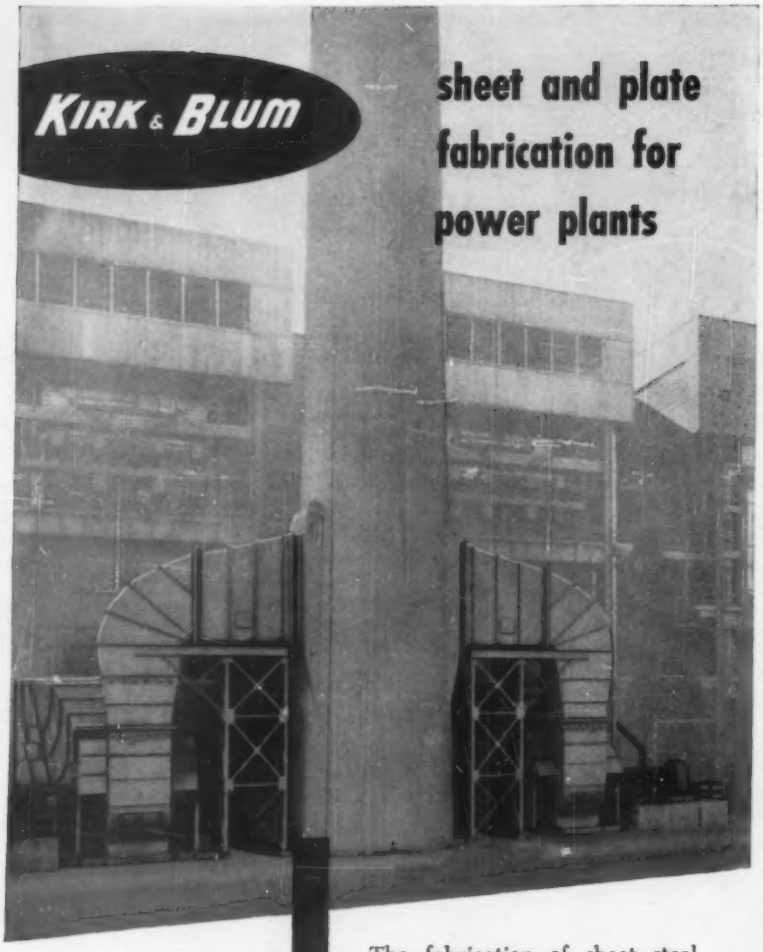

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float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, as well as trouble-shooting and repair. Armstrong Machine Works.

217 Steam Trap Selector — Twelve-pp Bulletin T-9 is designed specifically to aid in selection and application of steam traps on chemical processing equipment. Features a foldout piping diagram for 22 pieces of typical processing equipment — each showing recommended steam trap and piping arrangements. Also contains selector tables. Yarnall-Waring Co.

218 Flexible Ball Joint — Catalog 215-B, 20-pp, describes advantages of company's flexible ball joints for use in piping for power, process, heating, chemical, construction, or hydraulic service. Includes engineering specifications and data on the standard 300 lb series and the series 600. Screwed, flanged and welding end joints are listed, as are insulating joints and jacketed joints for handling asphalt and other liquids that solidify unless heated. Barco Mfg. Co.

MECHANICAL POWER TRANSMISSION

220 V-S Drive Selection Tips — Bulletin 20P50, 44 pp, carries handy multi-color tables for quick and easy selection of variable speed Texrope drives. In addition to providing these tables for A, B, C and D section variable speed drives, booklet includes information on design features, drive principles, horsepower rating tables, speed range table. Allis-Chalmers Mfg. Co.

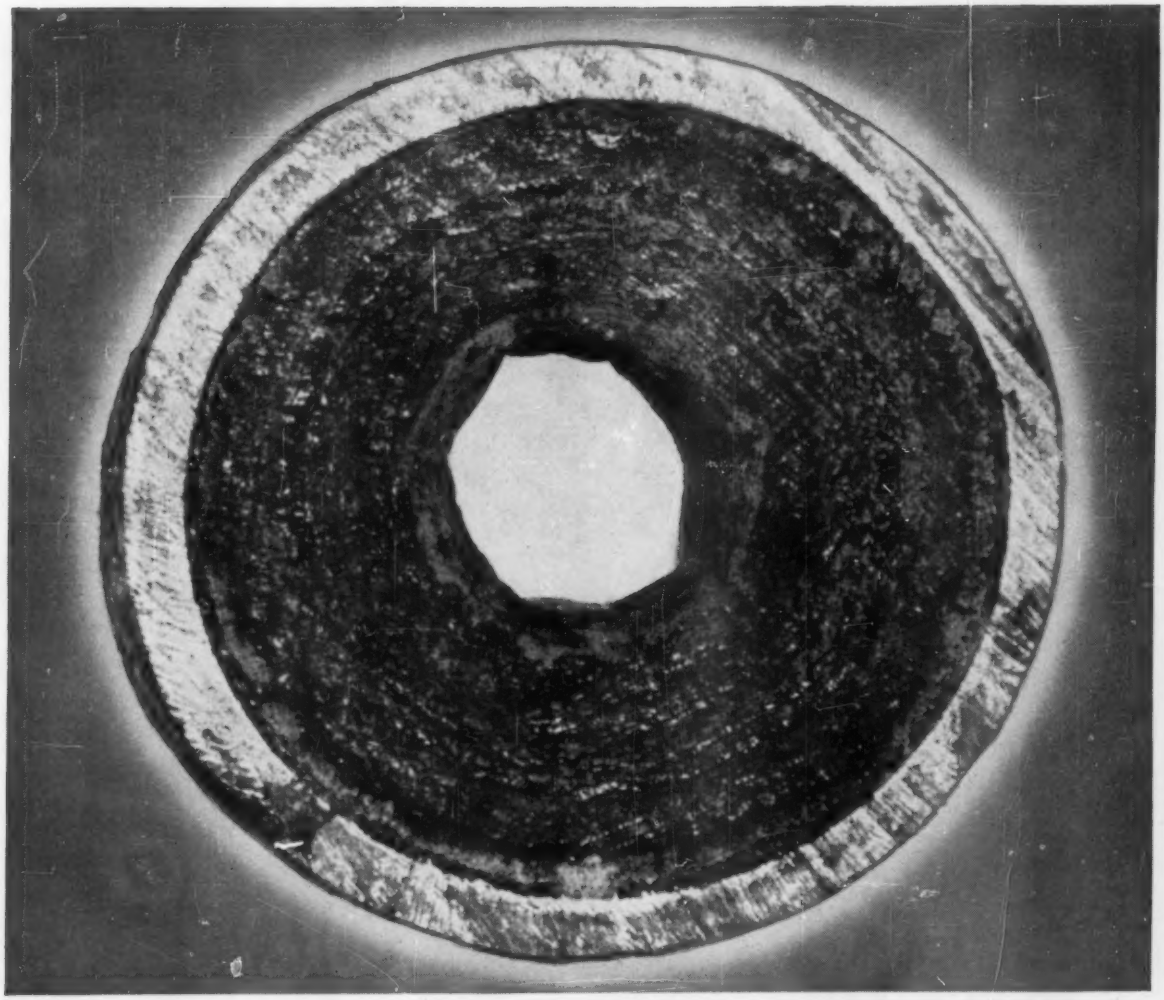
221 Fluid Drives — Bulletins 9419 and 9519 are an illustrated catalog and selection guide on company's new Type VS Class 2 Gyrol fluid drives. Catalog discusses advantages and applications of the drives, covering speed control, power savings, simplified installation, etc. A sectional view shows construction and principle of operation. Dimensions for six sizes of drives are provided. Selection guide consists of tables indicating proper drive to use. American Blower Corp.

222 Speed Reducers — Design and operation advantages of company's line of Torque-Arm speed reducers are outlined in 28-pp Bulletin A-637. Includes selection tables for double and single reduction units, bore dimensions and bushings, data on overload releases, flange mounted speed reducers, and recommended V-belt drives. Dodge Mfg. Corp.

ELECTRICAL EQUIPMENT

223 Testing Instruments — Bulletin 19–56, 16-pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric tests sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, including chief features, operating ranges, and applications. James G. Biddle Co.

224 Industrial Systems — Bulletin GED-3039, 48 pp, gives information on distribution system planning. Features, advantages, application, operation and other



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SCALE—layer upon layer of it—has reduced the inside diameter of this pipe to practically nothing. It's a common occurrence in some power plants, and the results are costly. The line must be taken out of service. That means production loss and expensive maintenance or replacement.

Scale, sludge, carry-over, and return-line corrosion are but a few of the problems that must be overcome to assure efficiency in boiler plant operation. In Dearborn's complete line of water conditioning products, there is the correct treatment to eliminate every water trouble—the properly balanced treatment to reduce unnecessary maintenance, avoid shutdowns, and protect valuable equipment.

Since 1887, Dearborn products have provided trouble-free water to users of steam in all types of industry. That's why, today, power engineers in leading industrial plants throughout the nation look to Dearborn for consultation and assistance in solving their water treating problems.

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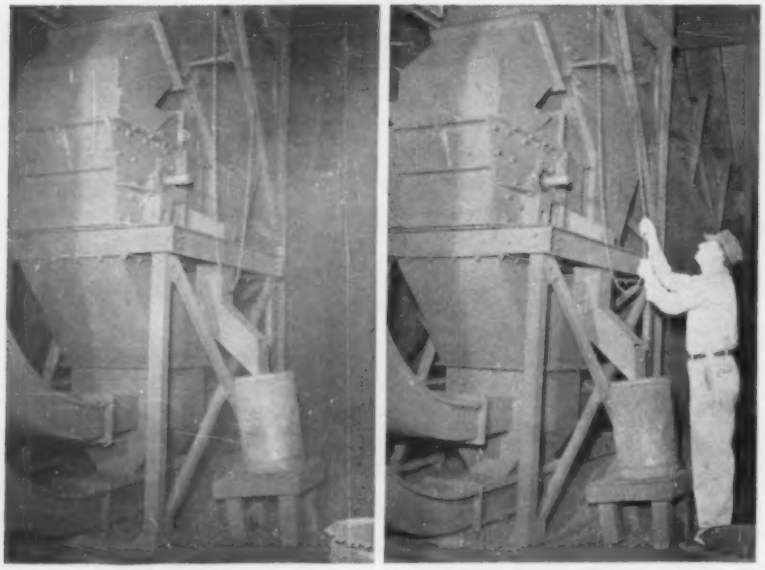

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This power plant in Danville, Virginia uses a **Johnson-March engineered liquid dust-control system** to eliminate troublesome coal dust in all stages of their coal handling. From railroad gondolas, where the coal is dumped on a conveyor, to the pulverizer, this plant has done away with the hazard of dust explosion, abrasion and wear and tear on their power plant equipment. Working conditions are greatly improved and maintenance time has been reduced to a minimum.

The before and after photos above are an example of the efficient manner in which the J-M system controls the coal dust in this plant. Even the efficiency of existing mechanical dust collectors can be improved by the addition of a Johnson-March liquid system.

Write today for a free analysis of your dust problem . . . no obligation of course.

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data on system-engineered equipment for industrial power distribution, including switchgear, unit substations, switchboards, transformers, busways, wire and cable, conduit products, voltage regulators, capacitors, circuit breakers, safety switches, panelboards, controls, motor controls, motors, turbines, rectifiers, and wiring devices are covered. General Electric Co.

225 On Copper Conductors — Publication C-25, 62 pp, is designed to help make the selection of bus conductors easier. Included in booklet are tables regarding such shapes as channels, ventilated square tubes and round tubes. There are tables for other rigid bus conductor shapes, also data on bare copper wire and cable as well as commonly used alloy wires. Also provided is a general discussion of copper, its physical and electrical properties. Photos illustrate many installations. The American Brass Co.

226 High Capacity Fuses — Form HCS, 6 pp, describes fuses of unlimited interrupting capacity on voltages to 600, designed to afford protection for loads of 600 to 5000 amp. Includes test data, charts on opening time, current limiting effect. Bussmann Mfg. Co.

REFRACTORIES, INSULATIONS

228 Insulations, Refractories — This 20-pp catalog features thermal insulations and refractories for general industrial applications. Organized for quick reference, catalog provides information on composition, physical and thermal properties and sizes of the various products. Lists chief advantages, covers materials for efficient control of temperatures from −400 F to 3000 F. Johns-Manville.

229 Refractory Concrete — Basic information on recommended practice for mixing and placing refractory concrete, used in the metal, power, ceramic, and petroleum refining industry as a material to withstand service temp to 2600 F or more, is presented in this 16-pp manual. Sections are devoted to special properties of refractory concrete, aggregates, refractory insulating concrete, and structural design. Universal Atlas Cement Co.

TUBING AND ACCESSORIES

231 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.

232 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

233 Tube Tools — Eight-pp Bulletin 58 describes advantages and application of company's line of tube cleaners, tube expanders and maintenance tools, including drills, brushes, accessory and specialty tools. Photos are included as well as size and selection data. Airetool Mfg. Co.

234 Heat Exchanger Tubing— Cited in this 30-pp catalog are typical

Best way to solve your tube corrosion problems

What condenser tube alloy best meets *your* specific operating conditions? What effect will a change of alloy composition have on *your* operating and maintenance costs? Will future changes in operating schedules impair the efficient functioning of *your* tubes?

Best way to answer these and many other questions affecting your condenser tube selection is to ask Bridgeport. Our 60 years of tube manufacturing and corrosion research, backed by modern methods and facilities, have led to the development of a wide range of tube alloys to meet virtually every corrosion problem. Here are some of the standard tube alloys Bridgeport offers:

Admiralty – Good corrosion resistance to most types of circulating water at low velocities. Resists dezincification. Excellent corrosion resistance to clean fresh water and in certain types of industrial and sewage pollution. A common choice for power stations for condensers, feed water heaters and heat exchangers.

Aluminum Brass – Excellent corrosion resistance to sea water. Resists impingement corrosion in water velocities from 6 to 10 ft. per second. Excellent corrosion resistance to chlorinated sea water when chlorine is used for slime control. Excellent corrosion resistance to clean and polluted fresh water. Ideal for severe operating conditions. Widely used by seaboard power stations for condensers and heat exchangers.

Copper – Good general corrosion resistance. Good impingement corrosion resistance where water velocities are low. Immune to dezincification. Resistance to cracking high. Excellent heat transfer rate. Widely used for heat exchangers, evaporaters and condensers, particularly for fresh water services.

Cupro Nickel – Considered the best copper-base alloy for all-around and impingement corrosion resistance toward sea water and saline waters. Has unusually high strength at elevated temperatures.

Aluminum Bronze – Good general resistance to impingement and corrosion in brackish water and in areas where water is contaminated by sewage and acid wastes.

Red Brass – Good corrosion resistance in fresh water. Excellent resistance to dezincification.

Muntz Metal – Similar to Admiralty in resisting corrosion effects of sea water. Resists dezincification in sea water and brackish water. Excellent resistance to corrosion in most fresh waters.

Bridgeport's Technical Service and Corrosion Laboratories are at your service to help you with specific problems. Call your nearest Bridgeport Sales Office for complete information.

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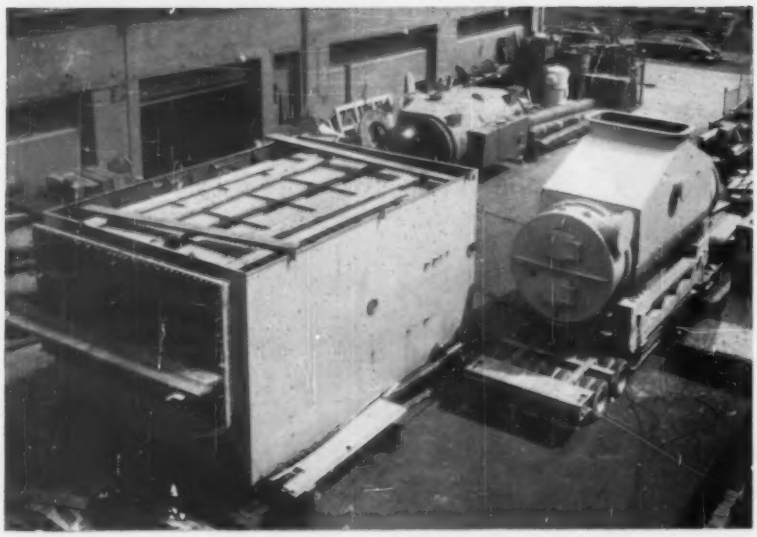

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cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required tubing that would withstand this rigorous wear. The International Nickel Co., Inc.

235 Tube Expanders — Catalog 88 119-pp, is full of detailed information about tube expanders and associated tools used for tube rolling. Profusely illustrated, catalog provides information relative to boilers, condensers, evaporators or miscellaneous heat exchangers. Special sections are devoted to expanders, accessories, measuring instruments, rollers, extensions and drives. Each type of equipment is fully described, applications are listed, and tables of engineering data included. Also covers tube expansion methods, tool maintenance, expansion calculations and charts giving pipe and tube sizes. Thomas C. Wilson, Inc.

BOILERS, GENERATORS

237 Packaged Boilers — This 16-pp illustrated catalog describes manufacturer's new Type VP package boiler. Following a section of background information is an outline of the principal design features of these boilers, which are shop assembled and provide steam capacities from 4000 to 40,000 lb per hour. Space requirements are shown in a table with specifications. Combustion Engineering, Inc.

238 Steam Generators — Illustrated Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-type boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Erie City Iron Works.

239 Improved Steam Generator — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data, and dimensions for the units which range from 20 to 6000 hp. Preferred Utilities Mfg. Corp.

240 Steam Generators — Bulletin 55-1, 22-pp, describes company's products and services, including not only steam generators but also custom metal fabrication. There are many photos of boilers in various stages of assembly. Engineering drawings of boilers producing up to 500,000 lb of steam per hr on standard fuels are included, as well as illustrations of units for waste heat application and those designed to utilize refuse for fuels — wood chips, coffee grounds. The Wickes Boiler Co.

241 Boiler Family — Bulletin B-3300-A describes a wide range of company's heating and power boilers and includes photos and cutaway views showing construction features. A list of bulletins on the various types of boilers is included. Titusville Iron Works Div., Struthers Wells Corp.

242 Standard Generators — Bulletin B-55-4 describes company's SC economy series of standard steam generators designed to reduce steam costs for indus-

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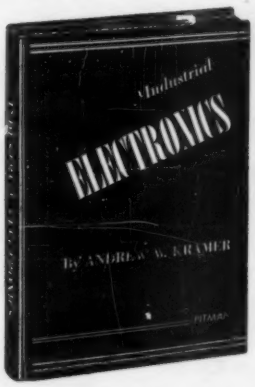

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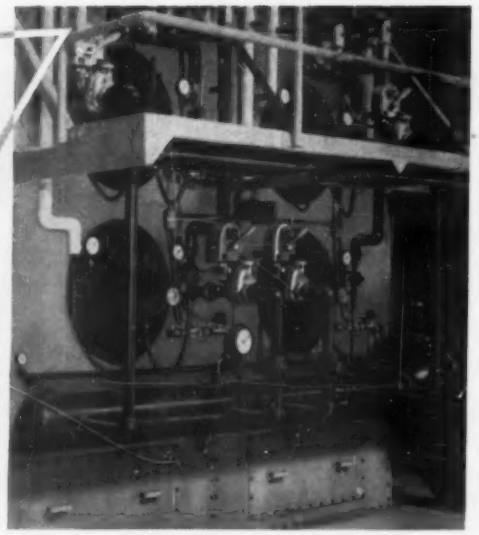

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trial plants. Pre-engineered, standardized steam generators offered in nine sizes, with capacities of from 50,000 to 150,000 lb per hour are described, and schematic and cutaway drawings of the units and design features are included. Foster Wheeler Corp.

243 Water Tube Boilers — This 12-pp catalog describes packaged water tube boilers, in capacities from 8000 to 50,000 lb per hour. Interesting as well as informative, this booklet uses color and illustrations to amplify text. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

244 Packaged Generators — Bulletin MH 3-54, 14-pp, gives detailed coverage to company's Type MH packaged water tube steam generators which are furnished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement layouts, construction details, auxiliary equipment, dimensions. Union Iron Works.

245 Shop Assembled Boiler — Sixteen-pp Bulletin G-76 completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. The Babcock & Wilcox Co.

LUBRICANTS

247 Lithium Soap Greases — This product information bulletin details qualities and specifications of company's multi-purpose lithium soap industrial greases. Advantages of multi-purpose grease use — such as prevention of lubricant misapplication, simplified maintenance procedures are discussed, together with performance characteristics. Sinclair Refining Co.

248 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, uses, properties. Standard Oil Co. (Ind.)

249 Bearing Lubrication — Vol. XL, No. 10 of this company's Lubrication magazine provides an excellent 12-pp article on industrial bearing lubrication. Illustrated with photos and drawings, text covers such subjects as bearing design; bearing surfaces; bearing overhaul; aspects of lubrication, including factors involved in choice of turbine oils and diesel lubricants, and the deleterious effects of moisture; and the life expectancy of bearing lubricants. The Texas Co.

INSTRUMENTS, CONTROLS

250 Boiler Feed Control — Bulletin 1003, a 12-pp catalog on boiler feed regulators, is illustrated with large application photos and detailed schematic drawings and charts. Relay and direct operation are covered. Case studies of representative boiler loads are presented to show stability of the Flowmatics in controlling feedwater. Copes-Vulcan Div., Blaw-Knox Co.

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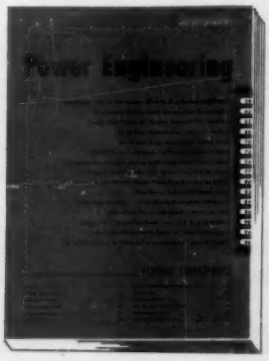

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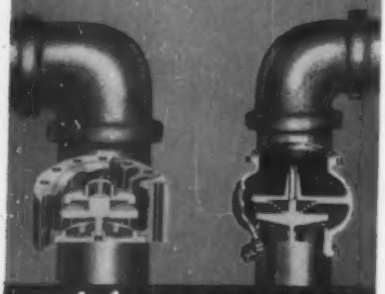

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252 Instrument Panels—Power and process plants can choose instrument and control panels to meet individual specifications from six standard designs described in 16-pp Product Specification G71-7. Complete specifications are furnished, as well as information on supports and mountings for tubes, wires and equipment, instrument mounting dimensions, and dimensions of standard instrument and control panels. Bailey Meter Co.

253 Easy Reading Gage — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, explains operation. The Reliance Gauge Column Co.

254 Oil Leak Detection — Eight-pp illustrated Bulletin 80, on the Paraprobe oil leak detection system for steam-type fuel oil heaters gives a detailed explanation of the operation of the system. Provides installation diagrams, standard specifications, explains determination of condensate flow rate. Davis Engineering Corp.

Postage-free cards for ordering catalogs are on page 113. You may also use the cards to order literature mentioned in the ads.

255 Solenoid Pilots — Several types of solenoid pilots for use with company's regulating valves are described in Form 1010. Lists reasons for economies in on-off control, describes applications, and gives type of pilot, material of construction, maximum pressure and maximum temperature for two- and three-way pilots in steam, air, gas and liquid service. Schematic diagrams of typical applications are given. Spence Engineering Co., Inc.

256 Indicating Flow Meter — Bulletin 18-A, 22-pp, discusses advantages, construction and operation of company's Type H indicating flow meter. Presents technical data on the principles and theory of fluid measurement and discusses orifice type meters and orifice meter principles. Offers examples of flow rate calculations. Schematic drawings and diagrams, tabulated technical data and specifications are included. The Meriam Instrument Co.

257 D-C Amplifier — Twelve-pp Bulletin MSP 111.1 provides pictorial diagrams and descriptive information on company's PowrAmp Model P, an electronic low-voltage linear amplifier designed to increase the speed and accuracy of low level d-c voltage measurements. Discusses performance and construction features of the amplifier and describes some applications. Hagan Corp.

COAL, ASH HANDLING

258 Tractor Shovel — The engineering, design and production stories of company's HD-11G tractor shovel are pictorially presented in 8-pp Catalog MS-460. Includes specifications and describes various features which mean easier servicing for less time-down and greater operator comfort. Allis-Chalmers Mfg. Co.

259 Spreader Stoker — Sixteen-pp Bulletin 800 describes manufacturer's

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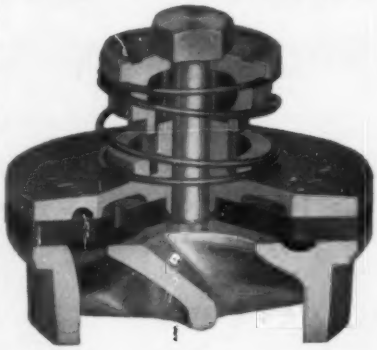

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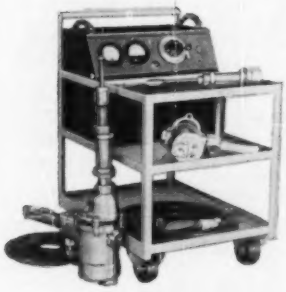

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260 Improved Crushers — Bulletin 12-C, 16-pp, describes company's line of crushers for reducing coal, coke, glass cullet, gypsum, lime, metal turning, sugar, sulphur and similar lump materials. Covers Knittel ring type crushers, two-stage double-roll crushers, single-roll crushers, and double-roll crushers. Photos, dimensional drawings and full specifications are included. Stephens-Adamson Mfg. Co.

261 Coal Crusher — Company's WC and WS series rolling ring coal crushers are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulverizer Co.

262 Why Liquid Diffusion — What liquid diffusion can do for power plants is explained in Form B, which tells how liquid diffusion compounds work and gives four practical applications. These include dust control in coal handling, fly-ash control, coal storage pile treatment and boiler cleaning. Johnson-March Corp.

WATER CONDITIONING

264 Water Conditioning Data Book — An excellent reference volume, Data Book 2478A contains 108 pp and presents a compilation of 78 chapters and tables. Subjects covered include hydraulics; impurities in water; chemical conversions; coagulant, acid and alkali dosages; chemicals used in water treatment; water treatment processes; boiler feed make-up requirements; alkalinity relationships; specific gravities; chemical reactions. Available to qualified power engineers, please state your job title when requesting this. The Permutit Co.

265 Handbook on Demineralizing — Comprehensive 40-pp Bulletin 5800-B compares various methods of water treatment, indicating the comparison between demineralizers and evaporators. It discusses the characteristics of the various types of available cation and anion exchange materials and offers data on operating costs of demineralizing. It tells when to use 2-bed, 3-bed, 4-bed, mixed or mono-bed demineralizers. It also indicates when decarbonators or vacuum deaerators should be installed. Cochrane Corp.

266 For Industrial Water Softening — Greensand, zeolite and resinous exchange water softeners are described in 8-pp Form S-105. Discusses features and applications of each of these basic types and illustrates some installations. Includes capacity data and general specifications. Also describes and pictures controls for water softeners, pressure filters and deionizers. Illinois Water Treatment Co.

267 Corrosion Treatment — "Corrosion Protection of Steam and Condensate Return Systems" is a folder on amine treatment for boiler and condensate systems. This treatment is described as affording surface protection of the metal as well

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as raising the pH value of the condensate. The Bird-Archer Co.

268 Steam System Treatment — This bulletin on Coravol for prevention of corrosion explains theory of corrosion, application of organic amines to steam systems (Coravol process) and presents case histories of use in different types of plants and industries. Coravol is part of a complete technical service providing chemical formulas for treatment of water, steam, brine, fuel. Western Chemical Co.

269 pH and Chlorine Control — The 12th edition of company's handbook "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrite, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium, magnesium, silica nitrate hardness. Available to qualified power engineers. W. A. Taylor Co.

270—Water Treatment—Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pretreatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

271 Carbon Dioxide Measurement — Technical Paper 133, 16-pp, discusses determination of CO_2 in water by conductivity measurements. Describes a new method developed for the determination of carbon dioxide which is applicable to analysis of waterside deposits, treatment chemicals and organic carbon in water. W. H. & L. D. Betz.

FUEL BURNING EQUIPMENT

273 Automatic Burner — Bulletin 420 contains approximately 30 pp of engineering data on a new burner unit for gas, oil or combination firing and sized for capacities to 42,000 lb of steam per hour. Separate sections of this looseleaf manual are devoted to photos and discussion of special features of the burner, general specifications, parts list, wiring and piping diagrams, explanation of operating sequence, and performance data. Available to qualified power engineers, please state your job title when requesting this bulletin. Peabody Engineering Corp.

274 Oil and Gas Burners — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Conversion table shows approximate relationships between quantity of oil burned, boiler capacity and air required for combustion. The Engineer Co.

275 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

OTHER EQUIPMENT

276 Product Guide — Manufacturing facilities for company's line of steam turbines, turbine generators, ship propulsion units, feed pumps, centrifugal compressors, blowers, centrifugal pumps, reduction gear, and other products are described in this profusely illustrated 50-pp catalog. Photos show manufacturing procedure. De Laval Steam Turbine Co.

277 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

278 Conveyor Belt Chart — Engineering data for standard conveyor belt constructions is given in this chart and accompanying sheet. Strength characteristics of eight popular ply and material combinations of conveyor belt constructions are provided. Each property is printed on the chart in a different color to facilitate comparison. Quaker Rubber Corp., Div., H. K. Porter Co., Inc.

279 Filter Underdrains — Information on filter underdrains and underdrain blocks is presented in two new bulletins. No. 901-B, 8 pp, describes the primary and secondary distributing system, typical installations, performance and specifications. Bulletin 6220-B covers various types of filter underdrain blocks. Infilco Inc.

280 Turbine Speed Control — Thirty-pp wire-bound Bulletin H-21 is titled "Fundamentals of Turbine Speed

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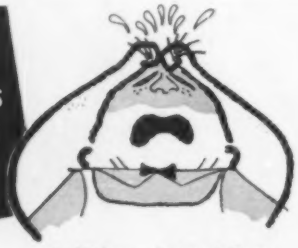

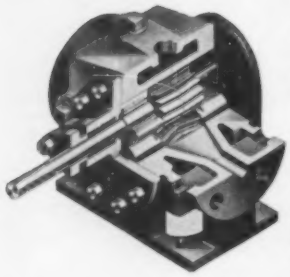

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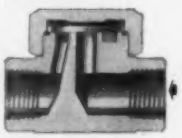

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Control." It is an elaborately illustrated, educational booklet intended to clarify the operation of common types of automatic speed control for steam turbines. An introductory section covers general fundamentals of automatic control systems, and includes a key to control terminology. Simplified diagrams show operating principles of actual control systems. Elliott Co.

281 On Chemical Cleaning — This series of seven folders covers the intangibles behind the chemical cleaning service offered by the company, such as training of cleaning specialists, accepted cleaning methods, safety consciousness, research, chemical cleaning equipment and service. Dowell Inc.

282 Duct Insulation — Engineering data and application instructions for company's semi-rigid, spun mineral wool duct insulation are presented in this informative bulletin. Thermal and sound absorption characteristics are presented in tabular form and physical, chemical, mechanical and handling properties are described. Baldwin-Hill Co.

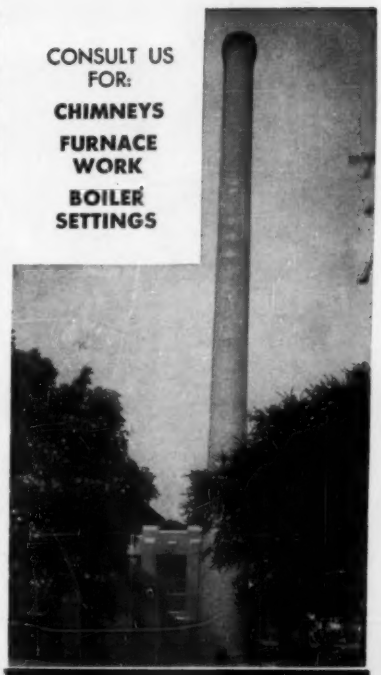
283 Sheet and Plate Fabrication — Illustrated in 40-pp Bulletin F-3 are products of this manufacturer, and equipment used to produce special sheet steel and alloy parts. Shows control panels, switch gear housings, cubicles and other electrical enclosures, boiler air ducts, smoke breechings, tanks. The Kirk & Blum Mfg. Co.

284 Nuclear Reactor Data — This 18-pp booklet lists significant data on every nuclear reactor known to be built or under construction in the world, including six in Russia. Material for the study was gathered from a wide variety of sources. A chart, listing reactors built since the first one in Chicago, and including those partially constructed or definitely planned and engineered for future construction, is included. Chart shows up to 50 principal characteristics of each reactor, including function and important technical features. Raytheon Mfg. Co.

285 Corrosion Control — Treatment of industrial equipment to control corrosion cannot be a hit-and-miss proposition, cautions this 6-pp folder. Examples are given of optimum control measures that may avoid costly, unsound treatment procedures, including minor physical or operating changes. Hall Laboratories, Inc.

286 Heat Transfer Apparatus — Condensed Bulletin HT-1 highlights representative products in company's line of heat transfer equipment. Includes oil heaters and coolers, strainers, evaporators, heat exchangers, radiafin air coolers, tubes, pipes, and coils. Cross-section views of typical units are shown; brief descriptions given. Schutte and Koerting Co.

287 Centrifugal Dust Collector — Twelve-pp Bulletin 100 introduces the Cyclo-trell multiple tube dust collector which operates on centrifugal collection principles and incorporates new features to boost collection efficiency and gas handling capacity. An illustrated explanation of operation and construction of this collector is accompanied by collection efficiency and capacity nomographs. Tables give design data for six sizes, from three to 20 tubes. Research-Cottrell, Inc.



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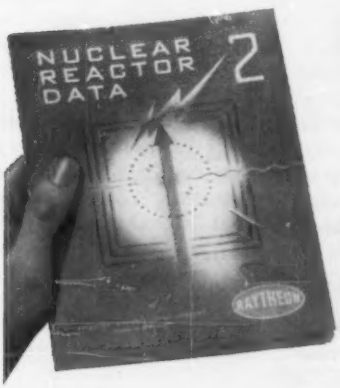

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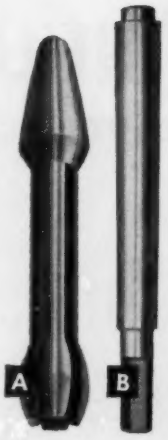

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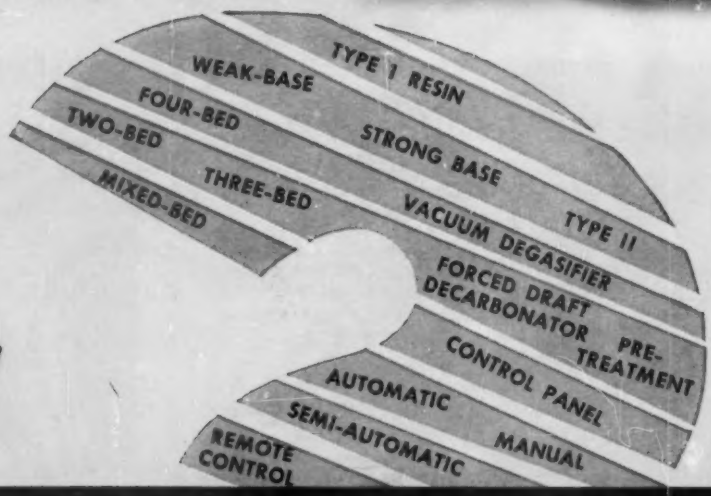
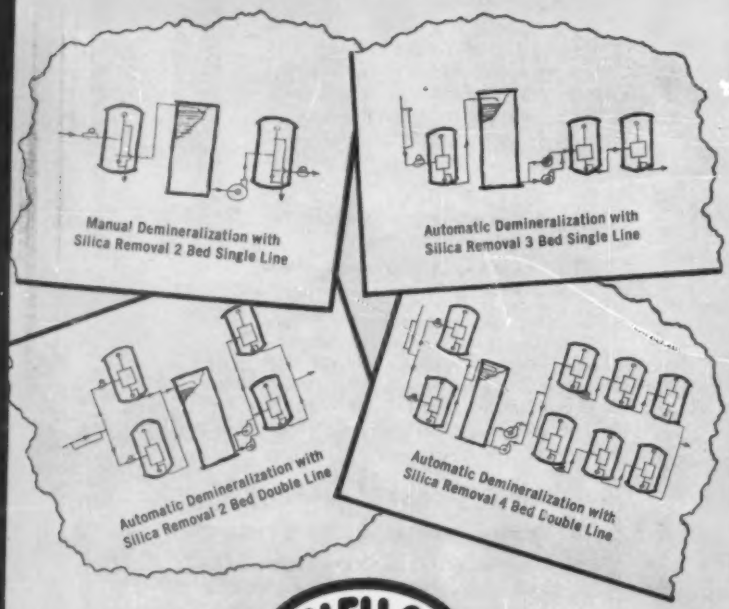


*INFILCO demineralizers are custom-built to solve the specific problems of each power plant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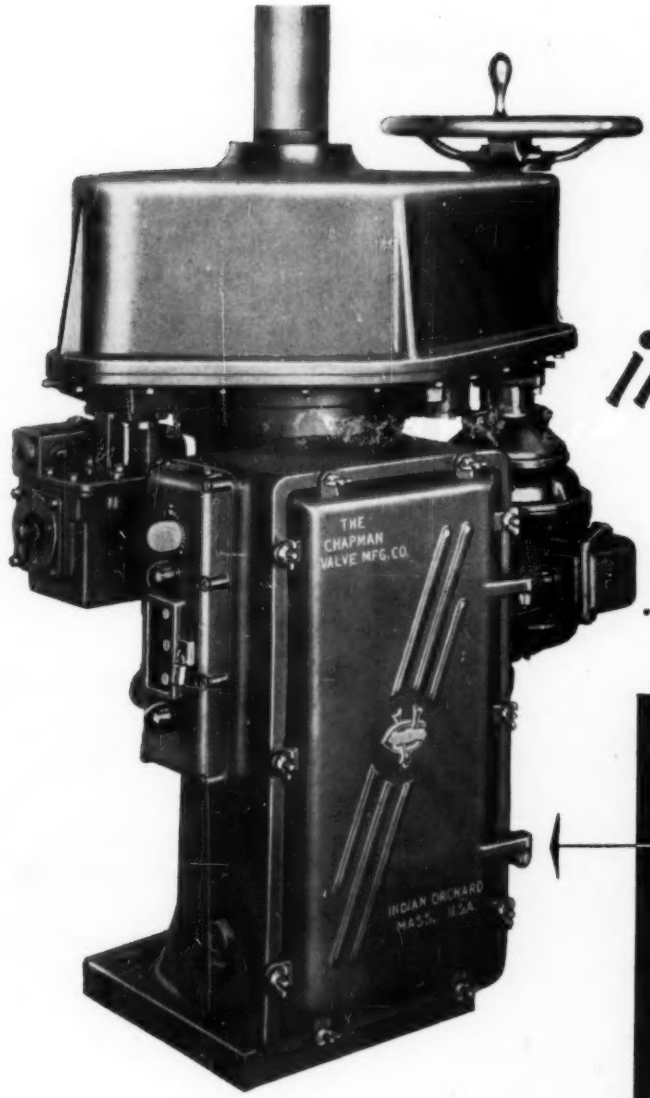

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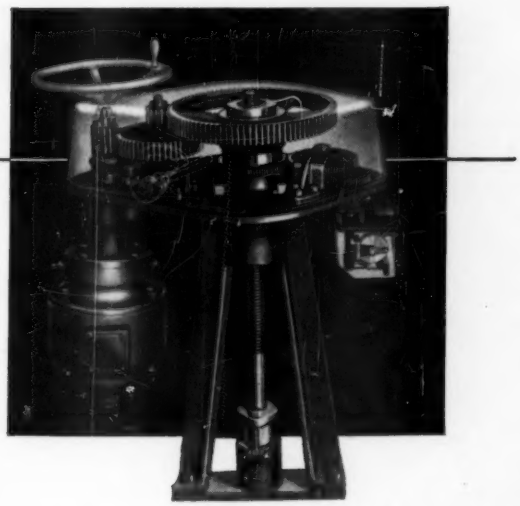

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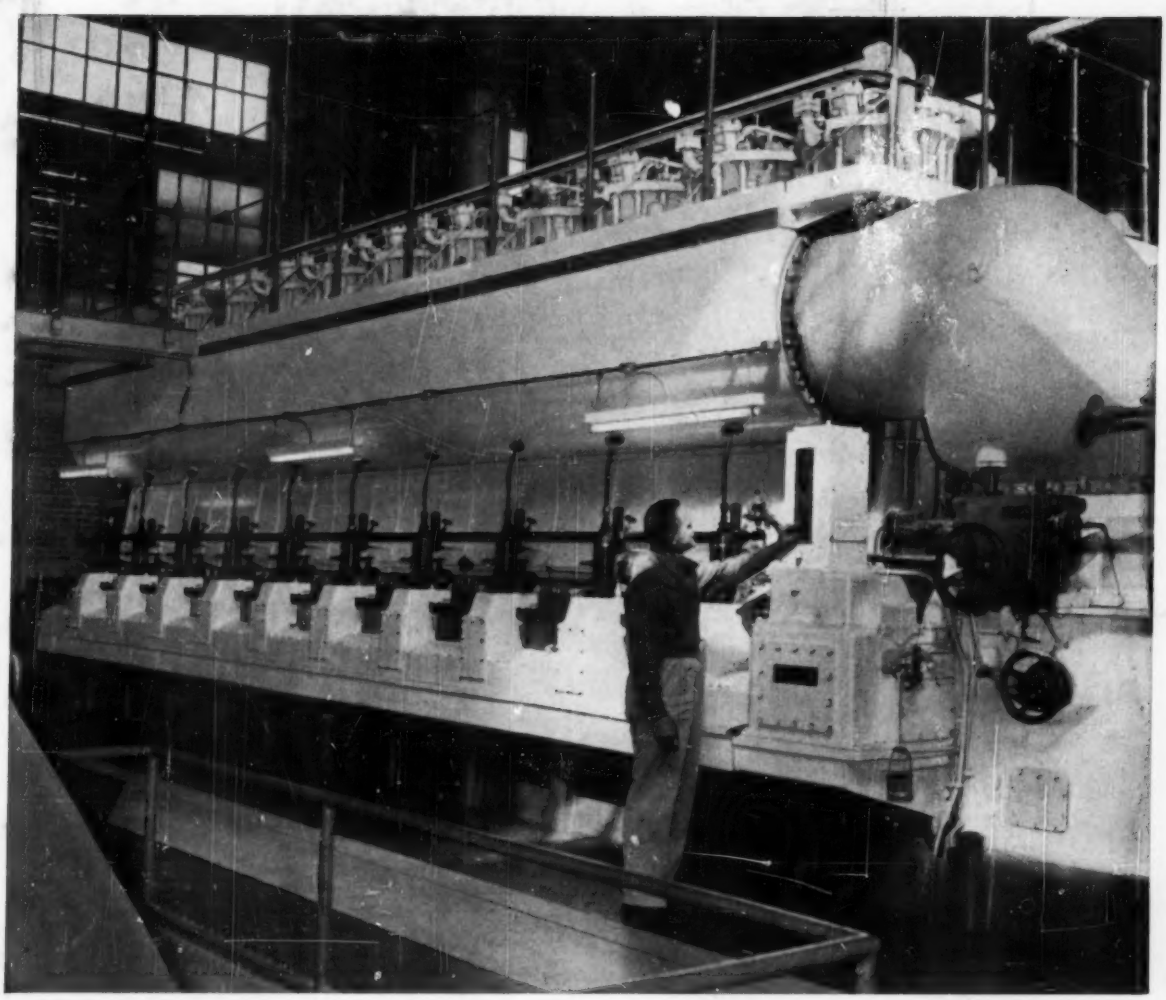

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